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United States Department of Commerce
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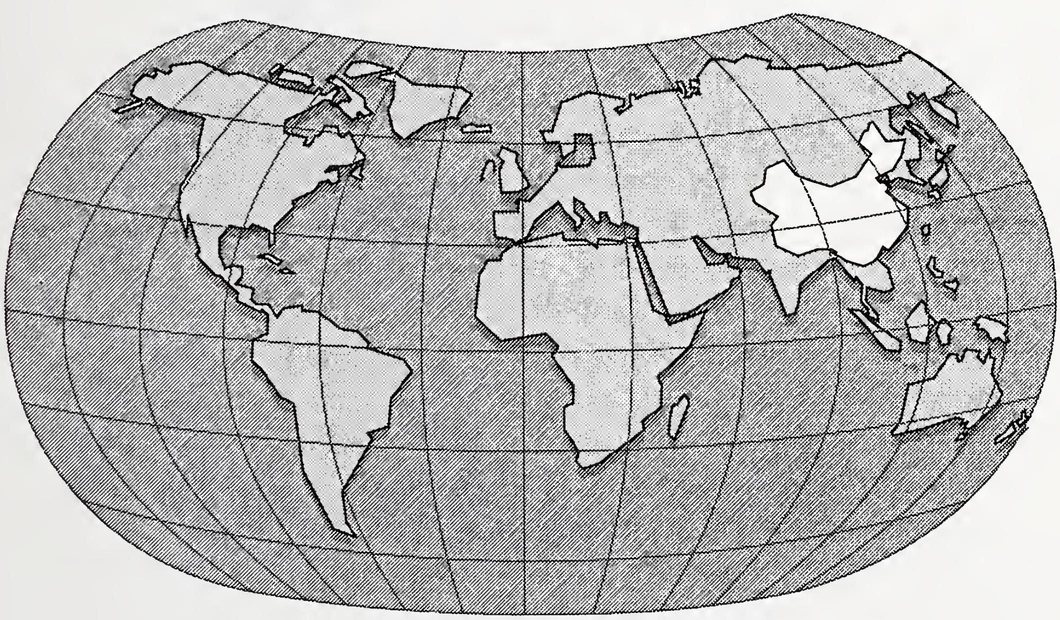
NIST Special Publication 893

A Glimpse of Materials Research in China

A Report From an Interagency Study Team on Materials Visiting China From June 19, 1995 to June 30, 1995

Stephen M. Hsu and Lyle H. Schwartz, Editors



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- Scientific Computing Environments[2]
- Computer Services
- Computer Systems and Communications[2]
- Information Systems

[1] At Boulder, CO 80303.
[2] Some elements at Boulder, CO 80303.

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Gaithersburg, MD 20899-0001

September 1995

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Technology Administration
Mary L. Good, *Under Secretary for Technology*

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National Institute of Standards and Technology
Special Publication 893
Natl. Inst. Stand. Technol.
Spec. Publ. 893
229 pages (Sept. 1995)
CODEN: NSPUE2

U.S. Government Printing Office
Washington: 1995

For sale by the Superintendent of Documents
U.S. Government Printing Office
Washington, DC 20402

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I. BACKGROUND AND OBJECTIVES

During the period June 16, 1995 to June 30, 1995, an interagency delegation of materials scientists from the Department of Commerce (DOC), Department of Energy (DOE), National Aeronautical and Space Administration (NASA), and the National Science Foundation (NSF) visited China and Hong Kong to explore areas for possible cooperation in materials research between the two countries under the general science and technology agreement. The visit is an important step in a series of exchange visits intended to facilitate the possible signing of a materials research protocol between the U.S. and China.

During the Sixth Meeting of the Sino-U.S. Joint Commission on Science and Technology Cooperation in Washington, D.C., April 1994, both sides expressed interest in establishing potential cooperation in the area of new materials. This subject received additional discussion at the January 1995 meeting of the Joint Commission in Beijing. The American delegation was led by Dr. John Gibbons, Science Advisor to the President, Office of Science and Technology Policy. Also present in the meeting were Dr. Mary Good, Under Secretary of Technology, Department of Commerce, Dr. Martha Krebs, Director, Energy Research, Department of Energy, Dr. Dan Goldin, Administrator of NASA, and Dr. Neal Lane, Director of NSF. During the meeting, the U.S. agreed to exchange study teams with China to define specific technical areas and projects and the four U.S. agencies present agreed to jointly explore the possibility of cooperation in materials.

After the meeting in Beijing, Dr. Lyle Schwartz of the National Institute of Standards and Technology was appointed to lead a team of materials scientists from the four agencies. The charge to the study team was to visit many of the research institutions in China with the help of the Chinese State Science and Technology Commission (SSTC). These visits were intended to familiarize the American scientists with the current research emphasis in China and allow direct interaction with the Chinese scientists. Additionally, the study team was to develop a report for use in identifying areas for cooperation that will be mutually beneficial to both countries. The composition of the study team and their brief biographies are in Appendices A and B.

Recognizing the daunting task of assessing the state-of-the-art in a nation with so vast a scientific and academic structure as China, the study team's itinerary was organized to split into four smaller teams which began together in Beijing, spread out to visit separate locations and then met again in Shanghai. The visit ended at the Hong Kong University of Science and Technology (HKUST) which graciously provided facilities for the drafting of this report. The itineraries of these four teams (Appendix E) allowed for visits to 30 institutions in a period of a week and one half. Reports describing each of these visits are assembled in Appendix F, and should be referred to for detailed description. While we recognize the superficial nature of each such visit, the array of contacts prepared the team to make some broad generalizations about the state of materials research in China.

II. GENERAL ASSESSMENT OF MATERIALS RESEARCH IN CHINA

In general, much of the research tasks at the institutions that we visited may be characterized as gaining parity with the western research capabilities in emerging technologies. The research topics range from those currently in favor in the U.S. to topics specific to the needs of the Chinese industry.

Preparing for China to take its place among the leaders in the 21st century, achieving world-class capability, and providing an alternate local source for materials technology appear to be China's primary goals. These goals are reflected particularly in highly emphasized areas such as advanced ceramics, intermetallics, and aluminum-lithium alloys.

How does one create a private industry from all public-held institutions? The Chinese science and technology policy aims to "create" a high technology from the current research institutions and universities. In the mid-1980's the universities and institutes of China were given instructions to finance increasing shares of their activities through business ventures, or "enterprises" as they call them. Some of the places we visited have been far more successful at this than others, claiming 50% to 80% of current research budgets attributable to such enterprises. As a result of this policy, one unique feature of Chinese research organizations is that they often have equipment in a particular research area from laboratory scale all the way to pilot plant scale, sometimes even manufacturing facility scale. As noted by our NSF representative, this rare vertical integration provides a potential test-bed for manufacturing research under realistic settings. In the U.S., research of this type is often inhibited by intellectual property rights and the need to protect proprietary know-how.

In general, research institutes seem to have adjusted to this new policy better than universities, with a consequential advantage over universities in equipment for further research at this point in time. However, since the research institutes in China can independently grant advanced academic degrees, they often become the preferred place for completing one's graduate study. On the other hand, under this climate, business aspects may drive the research agenda of such institutes, and research activities tend to emphasize product development or process improvement. Basic research on fundamental understanding in these institutes may suffer. During the visits to various institutions, we have observed different degrees of balance between basic research and product development. Some institutions are much better than others in this respect. This leads to an interesting observation: the institutions with which we might wish to collaborate on basic research may not be the best equipped to do so, and the institutions which are best equipped may not necessarily be oriented toward basic research. There are obviously many exceptions to this observation and this fact does not rule out potential areas of collaboration, especially because of the large number of institutions and people engaged in such activities. At the same time, it may limit the number of areas likely to be mutually beneficial to both sides, a requirement *sine qua non* in any agreement between the two nations.

The technical skills of many of the people that we met are very high, and their education has often been augmented by stays at institutions abroad. Often those foreign visits have led to long-term collaborations which make up a great part of the current list of existing interactions between the U.S. and China.

By contrast with the quality of the personnel, in some of the institutions we visited, the general laboratory conditions are not well maintained and some of the equipment and facilities are not at top performance levels, and some may be out-of-date. This condition is being improved by the Chinese. At the same time, at some of the premier research institutions, we found excellent equipment and instrumentation, some donated by foreign venture partners, some purchased with profits earned from sales of product or research services, and some purchased through low-interest loans to China by the World Bank. The choice of institutions to collaborate with therefore is important at this time.

Scientific collaboration and personnel exchange demand a minimum degree of compatibility of standards, and we noted two areas in which some of the Chinese laboratories require significant attention to reach world-class levels. Firstly, we found the concern and expenditure in the area of health and safety appeared not to have received sufficient priority. Scientists used to conditions in U.S. laboratories would feel very uncomfortable and in some instances would be exposed to potential "hazards" while working in some of the laboratories we visited. This would certainly be an inhibition to exchanges of personnel. Secondly, lack of widespread use of calibration and measurement standards reduces confidence in the reliability of the data generated. This is an area in which collaboration may result in significant impact very quickly and a specific recommendation is made under the section of recommendations and mechanisms.

There is good reason to expect significant and continuing improvement in the quality of many individual university departments, and it is noteworthy that a number of universities have been identified as "key of keys" institutions slated for special government attention. These universities include four visited by the study team: Tsinghua University at Beijing; Shanghai Jiao Tong University; Zhejiang University in Hangzhou; The Sichuan Union University in Chengdu. These universities may be expected to have greater access to equipment and operating expenses as well as the best qualified students. The materials research we saw at these institutions was of the highest levels among the universities that we saw in China.

At many of the institutions visited we were given specific research proposals for possible collaborations with US counterparts. These proposals, listed in Appendix G, were generally of two kinds: basic research or "partnership for joint venture." These proposals are useful in identifying potential topical areas that are of mutual interest.

III. CONCLUSIONS

Significant cooperation between Chinese and U.S. institutions already exists. In Appendix C, we have gathered a partial list of such collaborations in materials research topics arranged by U.S. agency. In addition, during the course of our visits, we learned of many current and pending joint business ventures with American companies. These American companies are usually very large companies which can afford the resources required to overcome the myriad hurdles required to initiate and maintain such interactions. When asked why any company would want to make such an investment in the institution, the most frequent answers were: lower cost and the opportunity to develop a foothold which might lead to later access to the developing Chinese market. Some of the Chinese universities or institutes claimed that they had technology which provided an acceptable local source or that the technology was truly unique, from either properties or low cost points of view, and it could not be obtained elsewhere. These exceptions are noteworthy, and are discussed in the individual site reports in Appendix F.

It is certain that cooperation between U.S. scientists and industries and their Chinese counterparts will increase. It is also certain that this process may be accelerated by concerted efforts by the governments of both sides. In the succeeding paragraphs we identify areas for technical focuses and suggest some mechanisms for developing cooperation. The strategies are divided into two general classes - those dealing with basic research, and those dealing with business opportunity.

Areas for cooperation:

Research opportunities for collaboration will most often take advantage of complementary strengths of the two sides. In this instance the strong characterization capabilities of U.S. universities and Federal laboratories may be an ideal complement to the strong synthesis and process orientation of most of the Chinese institutions. Specific areas for such efforts lie in the production of rare earth materials and their alloys, taking advantage of the natural resource base in China; in the growth of single crystals of electronic, optical and electro-optical materials such as GaAs, InP, etc. and intermetallic single crystals and bicrystals useful for mechanical property studies, an activity which has received decreasing attention in the U.S. recently, but one necessary to complement device development and fundamental programs; and in the area of polymer science in which synthesis of specialized molecular structures is often demanded to further understanding in areas such as polymer blends and polymer surface interaction. In another promising area for interaction, prosthetic materials and devices, the synthesis and manufacturing are superior in the U.S., while work on prosthetic devices was in evidence in many of the sites visited.

In addition to these broad areas which represent strengths of many universities and institutes, additional noteworthy opportunities are highlighted in the individual visit reports in Appendix F. Among these are low cost manufacturing of ceramics, piezoelectric and ferroelectric materials Tsinghua U., Beijing); nonlinear optical crystals (Institute of Physics, Beijing); tribology and solid lubrication (Lanzhou Inst. Of Chemical Physics); corrosion protection and testing (Inst. of Corrosion and Protection of Metals and Corrosion Science Lab., Shenyang); phase equilibria of ceramics (Shanghai Inst. Of Ceramics); and shape-memory materials (Zhejing University).

IV. RECOMMENDATIONS AND MECHANISMS

Issue: *Research opportunities demand scientist to scientist interactions which may be facilitated by making travel funds available for participation in the array of scientific meetings already occurring world wide. However, to accelerate this process, special events may be desirable in each of the targeted research areas to focus attention on the U.S. - China interaction.*

Recommendation: Bilateral workshops or conferences should be hosted in China and in the U.S. with expenses paid by each government for their own scientists. Technical areas for each of these events should be agreed upon by sponsoring government agencies from both countries and the primary goal of such interactions should be to stimulate future collaboration in addition to the welcome side benefit of information transfer.

Issue: *Chinese scientists do not in general have access to the most advanced characterization facilities, especially those usually designated "National User Facilities" such as synchrotron and neutron sources.*

Recommendation: Three options should be considered. As one option, access to U.S. facilities might be encouraged, subject to the usual acceptance of proposals from the Chinese scientist by the facility use committee, and with travel paid by the SSTC. A second option is to encourage a collaborative interaction with the U.S. partner carrying out the facility use. This second path is favored by the delegation for reasons of geographic convenience as well as the huge technical gap between current local facilities in China and the User Facilities in the U.S. A third option may be of interest to the Chinese government, but implies a more permanent commitment. It is possible for the Chinese institutions to become partners with others in the U.S. or elsewhere, and "buy" access to these facilities by paying direct acquisition costs for outfitting a beam line, and continuing operating costs for the technical staff who remain at the facility.

Issue: *Coordination of the interaction between scientists in the two countries should not be so bureaucratic as to reduce cooperation; however, if approval of a project under the protocol is to result in some additional funding to the Chinese participant by the SSTC, then the U.S. must provide some assurance that the individual(s) and agencies within the U.S. concur and see benefit to the agency program in the proposed collaboration.*

Recommendation: Proposals from China under new materials protocol should be forwarded by the SSTC to a central location in the U.S. which will funnel them to the relevant agency for assessment and collect responses for return to the SSTC. The SSTC should develop a similar process to deal with proposals originating in the U.S.

Issue: *U.S. scientists are likely to be reluctant to initiate activity with Chinese counterparts and the U.S. effort may be solely reactive without encouragement.*

Recommendation: Agency program announcements should be made to activate the U.S. research community and stimulate the desired action, be it for travel funds, conference sponsorship, or research proposals.

Issue: *A possible area for collaboration exists in the arena of materials property data; however, acceptance of data generated in China demands agreement upon measurement standards and adoption by China of some practices for conformity assurance for testing labs. This subject is actively being pursued under an agreement between NIST and the Chinese State Bureau of Technical Supervision. We do have one specific recommendation to make, uncovered as a byproduct of using NIST Standard Reference Materials as gifts to our hosts at many institutions. It quickly became clear that the cost of these SRM's was a major factor in their infrequency of use: however, by law, NIST must recover the cost of production through sales.*

Recommendation: NIST should work with organizations such as AID to develop strategies to make Standard Reference Materials available at highly reduced costs to developing nations including China.

Issue: *This delegation was constituted of scientists, ill-equipped to evaluate the business aspects of the many such opportunities presented to us. Our visit to HKUST in Hong Kong gave us further reason for caution, as local businessmen with extensive contacts in China emphasized their difficulties in overcoming barriers to joint venturing. We were impressed, however, with the obvious advantages which might accrue to those successful ventures which would capture a measurable share of the rapidly growing Chinese market. At almost every site we visited, we found the presence of active efforts by business representatives from many lands to establish interactions. Joint ventures* *were identified by our hosts, equipment was identified as having been donated by foreign-based businesses, and during our visit we often ran into visitors from some company or other from Europe or Asia. No effort by the U.S. government seems necessary to encourage action by large multinational corporations, many of which are already in collaboration with one or more Chinese institutions. However, medium sized businesses in the U.S. may not be willing to commit resources on a blind search through China to find such an opportunity.*

Recommendation: Consider hosting a "business fair" in the U.S. to allow a modest number of Chinese institutes to display their wares. U.S. hosts might be the DOC Technology Administration in collaboration with some private group, such as the National Center for Manufacturing Sciences. Chinese coordination should likely be through the SSTC, but assistance by a knowledgeable organization such as HKUST might be desirable to optimize the presentation of the Chinese work for the U.S. business audience. Such a business fair, if successful could lead to more targeted subsequent visits to China by U.S. company representatives.

V. FUTURE PLANS

The Chinese in their presentation by Dr. Ma Manhe of SSTC suggested the following cooperative research topics in advanced materials: Automotive materials, High temperature materials, Composites, Ceramics, Polymer materials, Metallic materials, Materials coating, etc. The time table for the cooperation was also suggested as following:

June 1995 - U.S. side finishes visiting China

September 1995 - Chinese side finishes visiting America

November 1995 - Exchange the cooperation projects drafts respectively

December 1995 - Define the cooperation projects

March 1996 - Implement the projects, and sign Sino-U.S. cooperation protocol in the field of new materials

If a formal protocol on materials research is to be signed, there are several steps which must be taken in sequence. This report will be delivered to the relevant sponsoring agencies. After the agency clearance, copies of the report will be transmitted to the Chinese SSTC in response to their request for feedback. We suggest that the report, after approval by the U.S. agencies, be made available to the public. A suitable vehicle for accomplishing this is by making the report a NIST Special Publication and making it available to the public through the National Technical Information Service.

The second step is arranging a return visit by a suitably composed technical delegation from China. The specifics of such a visit will require consultation with the Chinese. The itinerary should be one suitable to the interests of both sides, influenced, we propose, by the findings presented in the earlier sections of this report. We propose that the return visit by the Chinese delegation take place no sooner than early November of 1995, to allow for sufficient time to prepare an effective itinerary focused on areas likely to lead to further cooperative efforts.

The third, and critical step in the follow up is the actual drafting and subsequent signing of the protocol. The members of this delegation are prepared to assist in this task as we may be asked, but understand the principal responsibilities to lie within the Technology Administration in the Department of Commerce in conjunction with the International Offices of the various agencies and with OSTP.

VI. ACKNOWLEDGMENT

The U.S. Delegation to China on New Materials acknowledges its debt of gratitude to the Chinese SSTC and its representatives who hosted us in Beijing and accompanied our four teams during our travels in China and our local hosts at the many locations visited. Without their assistance our travels would have been more complex, our observations more limited, and our nerves considerably more frayed. We also thank our hosts at HKUST whose patience in supplying our needs enabled the completion of the first draft of this document before we departed Hong Kong for our respective home destinations.

VII. APPENDICES

APPENDIX A.

TEAM COMPOSITION

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VII. APPENDIX B.

BIOGRAPHICAL SKETCHES OF TEAM MEMBERS

Dr. Lyle H. Schwartz, Study Team Leader, Director, Materials Science and Engineering Laboratory, National Institute of Standards and Technology, Department of Commerce.

Lyle H. Schwartz was appointed Director of the Materials Science and Engineering Laboratory in October 1984. He is responsible for NIST's programs involving more than 360 scientists, engineers, technicians, and support personnel, and annual expenditures of approximately $65 million.

Outside of NIST, Schwartz is active in many materials policy roles. He is chairman of the intergovernmental committee on Materials Technologies. He serves on a number of technical committees in the materials sciences, is a Fellow and past member of the Board of Trustees of ASM International, and is a member of TMS, American Physical Society, and the Materials Research Society. He is chairman of the Board of Governors of the Institute for Mechanics and Materials (University of California, San Diego), and serves on the Advisory Committee for the Whiting School of Engineering, Johns Hopkins University. Schwartz received the 1990 Presidential Rank Award of Meritorious Executive for outstanding government service. He was elected member of the National Academy of Engineering, 1994.

Schwartz is a graduate of Northwestern University, Evanston, Illinois, having received his bachelor of science in engineering (1959) and doctorate (1964) in materials science. He began his teaching career at Northwestern as an assistant professor in 1964, became a professor in 1972, then director of the Northwestern University Materials Research Center in 1979.

Schwartz has published more than 90 papers in the areas of phase transitions in iron alloys, applications of Mossbauer spectroscopy, x-ray and neutron diffraction, characterization of catalysts, and policy issues related to materials science and engineering. He is a co-author of two textbooks on x-ray diffraction.

Dr. Stephen M. Hsu, Coordinator of the Study Team, Leader, Surface Properties Group

National Institute of Standards and Technology, Department of Commerce

Dr. Hsu graduated from Virginia Polytechnic Institute and State University in 1968 in Chemical Engineering and went on to obtain a M.S. and Ph. D. in Chemical Engineering from the Pennsylvania State University. He spent four years at Amoco Research Center at Naperville, Illinois before joining the National Bureau of Standards in 1978 as a research engineer. At NIST, he progressed to Group

Leader in 1979 and became the first Division Chief of Ceramics in 1985. He successfully organized the Ceramic research effort at NIST into a national center of excellence. In 1991, he spent 9 months at Pennsylvnia State University as a Visiting Professor of Chemical Engineering exploring mateial processing techniques. This was followed immediately as an Eshbach Visiting Fellow in the Materials Sciences Department of Northwestern University exploring surface science and microtribology research. Upon returning to NIST in 1992, he established a new research group on surface properties of materials.

Dr. Hsu is a member of the American Institute of Chemical Engineers, American Society for Testing and Materials, Society of Automotive Engineers, American Society of Mechanical Engineers, Am. Soc. of Tribologist & Lubricating Engr., and American Ceramic Society. He has over 100 invited talks, 8 keynote lectures, 160 publications, 3 Patents, 7 Special Publications, and 7 Standard Reference Materials.

His research interests include three major areas: 1.) Microstructural design of Ceramics - Multilayer ceramic processing - Machining of ceramics - Ceramic powder characterization - Surface oxidation of ceramics & ceramic powders; 2.) Wear Maps and wear Mechanisms of materials · Contact Mechanics - Asperity-Asperity interactions - Surface texture design - Origin of friction & stiction - Adhesion and deformation; 3.) Surface Chemistry of materials - Measurement of thin films on solids - Molecular structural effects on lubrication · Lubrication of advanced materials · nanoindentation - microtribology

He received many awards and honors including: Phi Kappa Phi, 1970 · Phi Lambda Upsilon, 1970 · Diamond Shamrock Fellowship, 1971 · Sigma Xi, 1974 · ASLE Captain Alfred E. Hunt Memorial Medal, 1980 · National Research Council Postdoctoral Research Advisor, 1980 · Department of Commerce Bronze Medal for Superior Federal Service, 1983 · ASME Research Committee on Tribology, 1984 · Invited Panelist, National Materials Advisory Board, (NMAB) NAS, 1985 · Invited Committee member on ceramic Tribology, NMAB, NAS, 1985-1987 · Chairman, Gordon Res. Conf. on Tribology, 1988 · American men and women of Science, 1989 · Department of Commerce Silver Medal for Meritorious Federal Service, 1990 · STLE Al Sonntag Award, 1991 · New York Academy of Sciences, 1993 · Who's who in America, 94 · Who's who Among Asian Americans, 94.

Dr. Hsu's professional activities include: Chairman, Interagency Coord. Committee on Ceramics, 86 · Chairman, Government Steering Committee, Tribology Information System (ACTIS), 84-92 · Member, COMAT Subcommittee on Ceramics, 85-92 · Member, Interagency Coord. Committee on Tribology, 83-86 Member, Committee on Ceramic Tribology, NMAB, NAS, 86-87 · Member, Com. on Technology Assessment and Transfer, Office of Technology Assessment, US Congress, 85-89 · Member, Int. Energy Agency Ceramic Standardization, 85-92 · Chairman, IEA Ceramic Powder Characterization Task, 87-92 · Member, VAMAS Working Group on wear, 85-91 · U.S. Coordinator, VAMAS International Wear Standards, 85-87 · Member, VAMAS Working Group on Hardness, 87-89 · Director, Society of Tribologists & Lub. Engr., 87-92 · Member, International Advisory Committee on Structural Ceramics, 8th CIMTEC, 93-94, Editorial Advisory Board, Tribology Letters, 94- present.

Iran L. Thomas, Acting Associate Director for Basic Energy Sciences

U. S. Department of Energy

Received a Doctoral degree in theoretical chemistry from Vanderbilt University in 1967. Member of the research staff at Oak Ridge National Laboratory Chemical Technology Division from 1967 to 1974. Served as Section Head of Physical and Engineering Chemistry of the Chemistry Division at Oak Ridge National Laboratory from 1974 to 1981. Manager of Phosphate Research, Occidental Petroleum Corporation, Occidental Research Corporation and Occidental Chemical Corporation from 1981 to 1983. Program Manager for Materials Chemistry in the Department of Energy's Office of Basic Energy Sciences, Division of Materials Sciences from 1983 to 1987. Director of the Division of Materials Sciences from 1987 to present. Currently also serving as the Acting Associate Director for Basic Energy Sciences.

C. T. Liu, Leader, Alloying Behavior and Design Group

Metals and Ceramics Division, Oak Ridge National Laboratory.

Dr. Liu received his B.S. degree in Mechanical Engineering from National Taiwan University and his M.S. and Ph.D. degrees in Materials Science from Brown University. He has been employed at ORNL since 1967.

Dr. Liu's research interests are in the areas of alloy development and design, high temperature deformation and fracture, previous metal alloys, refractory alloys, and ordered intermetallic alloys. He has contributed to more than 200 technical papers and reports in these fields and has been granted 16 U.S. patents for the development of ordered intermetallic alloys and precious metal alloys for high-temperature structural applications.

Dr. Liu has received a number of awards and citations. A fellow of the American Society for Metals, Dr. Liu has won three IR-100 Awards from Research and Development Magazine, holds Honorary Platinum Membership from the International Precious Metals Institute (IPMI), and was the first recipient of IPMI's Henry J. Albert Award in 1980. He has received awards from the National Aeronautic and Space Administration and the U.S. Department of Energy (DOE) for contributions to the development of special structural alloys for space applications. In 1985, he was named the Scientist of the Year by Martin Marietta Energy Systems, Inc., and was appointed Corporate Fellow; he is a winner of the Martin Marietta Corporate Jefferson Cup Award. Brown University also honored Dr. Liu as a Distinguished Alumnus for his scientific and technological accomplishments. In 1986, he received a special award for Excellence in Technology Transfer from the Federal Laboratory Consortium. In 1988, he received the E. O. Lawrence Award in the category of material research, and the award was granted by the U.S. Department of Energy on behalf of the President of the United States of America. In 1990, he was named Principal Editor of the Journal of Materials Research published by the Materials Research Society. Now, he is an Editor of the new journal "Journal of Intermetallics" established in 1992, and Associate Editor of Materials Letters.

Dr. Thomas J. Barton, Distinguished Professor of Chemistry

Iowa State University, Ames, Iowa 50011

B.S., Lamar State University, Texas, 1962; 1962; Ph.D., University of Florida, 1967; NIH Postdoctoral, Ohio State University, 1967; Iowa State University, 1967-present; Director of the Ames Laboratory (U.S. Department of Energy), 1988-1994; National Academy of Science exchange scientist to Soviet Union, 1975; Wilkinson Teaching Award, 1975; NATO Collaborative Scientist in France, 1976; Japan Society for Promotion of Science Lecturer, 1981; Editorial Advisory Board of Organometallics (ACS), 1982-1985; Frederic Stanley Kipping Award (ACS) in Organosilicon Chemistry, 1982; Outstanding Teacher Award (Iowa State University), 1982; CNRS Professeur d'echange (Universite de Montpellier), 1983; Royal Chemical Society (England) Research Fellowship, 1983; Iowa governor's Science Teaching Medal, 1983; MASUA Honor Lecturer, 1984; Burlington Northern Foundation Faculty Achievement Award for Excellence in Teaching, 1988; Outstanding Scientific Accomplishment in Materials Chemistry (DOE Materials Science Division), 1989.

His research interersts are: Synthetic and mechanistic organosilicon chemistry, high temperature gas-phase molecular rearrangements, generation of reactive intermediates, synthesis of novel precursors for silicon-based ceramics, synthesis of electrically-conducting and optoelectronic organic polymers, strained ring chemistry. He has 150 publications in refereed journals. 250 contributed, invited and plenary lectures in U.S. and 12 other countries and he holds 9 U.S. patents.

Dr. Paul F. Becher, Leader, the Structural Ceramics Group

Metals and Ceramics Division, Oak Ridge National Laboratory.

While at the Jet Propulsion Laboratory at California Institute of Technology in 1965-66, he became interested in the mechanical behavior of ceramics. This led him to investigate grain boundary sliding mechanisms in aluminum oxide while earning a Ph.D. degree at North Carolina State University in 1970. Prior to joining ORNL in 1980, he directed research on the processing, fracture, and deformation of ceramics at the Naval Research Laboratory. His research team currently is focusing on modeling and experimental studies on how the mechanical properties of ceramics and composites are influenced by microstructural and interfacial characteristics.

He is the author/co-author of some 180 technical publications in these fields and has presented numerous invited lectures in the U.S. as well as Japan and Europe. He is the recipient of the Purdy Award and the Sosman Memorial Lectureship from the American Ceramic Society, a Martin Marietta Corporation Jefferson Cup, a DOE Materials Sciences Research Award, and an Alexander Von

Humboldt Foundation Senior Scientist Research Award which supported his research at the Max-Plank-Institute for Materials Research in Stuttgart.

Dr. Roger K. Crouch, Chief Scientist, Microgravity Science and Applications Division

NASA, Washington D. C.

Dr. Roger K. Crouch, Chief Scientist of the Microgravity Science and Applications Division (MSAD) in NASA's Office of Life and Microgravity Sciences since 1985. He is responsible for the scientific content of the MSAD program including disciplinary priorities, programmatic priorities, budget distributions, PI selections, flight payloads and future planning. He also has responsibility for long range planning of flight and ground based programs which develop and fulfill the programmatic strategic plan. He is the interface with extramural advisory groups to assure scientific and technological relevancy of the program. He is responsible for the establishment of cooperative research programs with international partners. Serves as co-chair of the International Microgravity Strategic Planning Group which enables the establishment of cooperative programs including development of flight hardware for the International Space Station. Serves as the co-chair of bilateral Science Working Groups with the European Space Agency (ESA), German Space Agency (DARA), French Space Agency (CNES), Japanese Space Agency (NASDA), Canadian Space Agency (CSA).

Prior to joining NASA Headquarters, Dr. Crouch was a researcher in materials science and condensed matter physics for over 20 years. His final position was as the leader of the Semiconductor Crystal Growth Group at the NASA Langley Research Center in Hampton, VA. In addition to being a Principal Investigator in the Materials Processing in Space program for the growth of PbSnTe in space, he developed facilities for the vapor growth (PVT, CVT and MOCVD) and Bridgeman growth of III-V, II-VI and IV-VI semiconductors. He developed various materials characterization techniques to assess electrical and optical properties of semiconductors. He also established an electro-optical device development program utilizing epitaxial techniques to fabricate devices such as light emitting diodes, infrared detectors, monolithic, heterogeneous and homogeneous device structures for flat panel and other displays. Dr. Crouch has published over 40 journal articles related to his research. He has won many awards, the most recent of which was a Special Achievement Medal in April, 1995 for his contributions to the development of NASA's microgravity program.

Dr. Crouch has a B.S. in Physics from Tennessee Polytechnic Institute in 1962, a M.S. in Physics from Virginia Polytechnic Institute in 1968, and a Ph.D. in Physics from Virginia Polytechnic Institute and State University in 1971. He was also a visiting scientist in 1979-80 at the Massachusetts Institute of Technology.

Dr. Robert O. Ritchie, Professor of Materials Science, Department of Materials Science and Mineral Engineering, University of California in Berkeley

He is also Senior Materials Scientist and Head of the Structural Materials Department in the Materials Sciences Division of the associated Lawrence Berkeley Laboratory, and a member of the University of California San Francisco/University of California Berkeley Bioengineering Faculty.

Dr. Ritchie received a B.A. degree (double first class honors) in physics and metallurgy in 1969, the M.A. and Ph.D. degrees in Materials Science in 1973, and the Doctor of Science (Sc.D.) degree in 1990, all from Cambridge University. Following periods as the Goldsmith's Research Fellow in Materials Science at Churchill College, Cambridge (1972-1974) and as a Miller Research Fellow for Basic Research in Science at the University of California in Berkeley (1974-1976), he joined the faculty in Mechanical Engineering at M.I.T. where he became the Class of 1922 Associate Professor in 1979. In 1981, he returned to Berkeley where he has been Professor of Materials Science since 1982; he was also Deputy Director of the Materials Sciences Division at the Lawrence Berkeley Laboratory from 1990 to 1994, and Director of the Center for Advanced Materials there from 1987 to 1995.

He has served as a consultant for both government and industry, including such companies as Alcan, Allison, Boeing, Chevron, Exxon, Garrett Turbine, GE, Grumman Aerospace, Instron, JPL, Northrop, Rockwell, Teledyne, Westinghouse and numerous legal firms. He has also acted as a consultant in the medical field to Baxter Healthcare, Carbomedics, Medical Inc., Medstone Intl., Shiley, St. Jude Medical, and USCI/Bard on the mechanical integrity of cardiac valves and other prosthetic devices. In addition, he has recently served as a member of several National Research Council Committees including "Advanced Space Technology", "Small Spacecraft Technology", and "New Materials for Advanced Civil Aircraft".

Dr. Ritchie is well known for his research in the fields of materials science, fracture mechanics and fatigue-crack propagation, having authored or co-authored over 250 papers and edited 8 books in the technical literature.

He has been the recipient of several awards, including the Journal of Engineering Materials & Technology Best Paper Award from the American Society for Mechanical Engineers (ASME) in 1979, the Marcus A. Grossmann Award from the American Society for Metals (ASM) in 1980, the Most Outstanding Scientific Accomplishment Award from the U.S. Department of Energy in Metallurgy in 1982 and in Ceramics in 1989, the Champion H. Mathewson Gold Medal from the Metallurgical Society of AIME in 1985, the George R. Irwin Medal from the American Society for Testing and Materials (ASTM) in 1985, the E-9 Award for the Best Presented Paper on Fatigue from ASTM in 1986, the Curtis W. McGraw Research Award from the American Society for Engineering Education (ASEE) in 1987, and the Rosenhain Medal from the Institute of Materials (London) in 1992; he was also named as one of America's Top 100 Young Scientist by Science Digest magazine in 1984. In addition, he was co-chairman of the Gordon Conference on Physical Metallurgy in 1992. He is Vice-President and Honorary Fellow of the International Congress on Fracture, a Fellow of the Institute of Materials (F.I.M.) and the American Society for Materials, a chartered engineer (C.Eng.) in the U.K., and an Honorary Visiting Professor at the University of Plymouth in England. He is listed in Who's Who in America.

Ms. Erin Sullivan, Policy Analyst, Office of Technology Policy
Technology Administration, Department of Commerce

At the Technology Administration's Office of Technology Policy, Ms. Sullivan assists the international division acquire foreign science and technology information, analyze foreign technology policy, and make this information more accessible to researchers and private industry.

Ms. Sullivan is a licensed attorney and previously worked at the American Embassy in Beijing as legal advisor in the commercial section. She counseled businesses; wrote extensively on Chinese regulation of trade and investment; and participated in negotiations on market access and intellectual property during 1992 and 1993.

Chinese politics, history and language have been a deep interest for her since she began undergraduate study in 1979. Since then, she has earned her bachelors degree in Chinese Studies, and a Juris doctor degree with emphasis on international law.

Dr. Jeffrey Wadsworth, Associate Director, Chemistry and Materials Science
Lawrence Livermore National Laboratory

Dr. Wadsworth obtained his B. S. in Metallurgy from Sheffield University in England in 1972 and went on to obtain is Ph. D. in 1975.

From October 1993 to present, he is responsible for leadership and management of the Chemistry and Materials Science (C&MS) Directorate. This Directorate consists of four scientific divisions which support the major programs at the Laboratory, perform work for agencies inside and outside of the Department of Energy under reimbursable contracts, and conducts fundamental and applied research in the areas of chemistry, materials, and solid-state sciences. From August 1992-October 1993, he was the Assistant Associate Director for Research and Program Development, responsible for planning, developing, and implementing a comprehensive program in chemistry and materials research and development, using internal and external funding, and for developing a technology transfer program within C&MS. From 1986 to 1992, he was the Manager of the Metallurgy Department in Lockheed Missiles & Space Company, Inc. in Palo Alto California. He was responsible for the general direction of research activities and for the acquisition of research funds and equipment for Metallurgy. He was the Staff Scientist in Lockheed from 1983 to 1986.

He is also a Consulting Professor at the Stanford University from 1980 to the present in the Department of Materials Science and Engineering. He serves on Ph.D. committees, examines candidates, and has taught undergraduate and graduate courses.

His professional society memberships include the American Society for Metals (Fellow), the Minerals, Metals, and Materials Society of AIME, the Materials Research Society, the American Ceramic Society, and the American Chemical Society. He has served as the Western Regional Materials Science and Engineering Committee, Workshop Chairman for Aerospace Industries, 1990. Member of the International Materials Reviews Committee of TMS, 1990 - Present, Chairman of numerous technical sessions of TMS, ASM, and MRS, and organizer of two technical conferences for TMS and MRS, in 1986 and 1989, respectively.

He is a co-recipient of the best paper award on Superplasticity and Superplastic Forming Conference, Blaine, WA, 1988, and a member of the TMS Membership Committee, 1983, Secretary, Vice-Chairman, and Chairman of the Northern California TMS, 1980-1983, Member of Refractory Metals Committee of the National TMS, 1981.

He received many awards and honors including the Honorary Degree of Doctor of Metallurgy by Sheffield University for published research, November, 1990, selected as NATO/AGARD Lecturer on superplasticity; presented lectures in Rome, Madrid, and Toulouse, October, 1989, elected Fellow of ASM International, 1987, "For outstanding contributions to design and manufacturing methods for steels and refractory metals, for the development of superplasticity in aluminum alloys, and for the study of the history and metallurgy of Damascus Steels." He was elected to Senior Member of the Research Laboratory, Lockheed, 1986, selected to give the Lockheed LOKTEK VIII presentation at the National Press Club, 1986, awarded Metallurgica Aparecida Prize for Steel Research, Sheffield University, 1976, awarded Brunton Medal for Metallurgical Research, Sheffield University, 1975, awarded United Kingdom Science Research Council Grant, 1972.

He has published about 200 papers in the open literature on a wide range of materials science and metallurgical topics, and has presented or co-authored about 170 talks at conferences or scientific venues

Dr. Alan L. Dragoo, Acting Team Leader, Metallurgy and Ceramics program

Office of Basic Energy Sciences, US Department of Energy

He joined the Department of Energy in 1989 as a program manager in the Division of Materials Sciences where he was responsible for administering grants and projects at the DOE National laboratories. From 1961 to 1989, he was with the National Institute of Standards and Technology. During that time he was involved in projects on the high temperature thermodynamic properties of molten alumina, oxygen-ion conductors, ceramic processing, hot-gaseous corrosion of SiC, and powder characterization.

He holds a B.S. and M.S. degrees in Chemistry from the University of Michigan and a Ph. D. in Physics from the University of Maryland. Dr. Dragoo was a recipient of the Department of Commerce Silver Medal in 1991. He is a member of the American Chemical Society, the American Ceramic Society and the Materials Research Society.

Dr. Bruce M. Kramer, Director, Division of Design, Manufacture and Industrial Innovation, National Science Foundation, Washington, DC

Dr. Kramer directs a $74 million program that is responsible for supporting university-based fundamental research in design and manufacturing and for all of the small business-oriented programs of the NSF, including the Small Business Innovation Research (SBIR) Program.

He received B.S., M.S. and Ph.D. degrees, all in Mechanical Engineering, from MIT, where he subsequently served as Assistant and Associate Professor of Mechanical Engineering from 1979 to 1985. In 1985, he accepted a Professorship in Mechanical Engineering at George Washington University, in Washington, DC, which he relinquished in 1995 to join the NSF.

Professor Kramer has taken leaves of absence from GWU as a visiting scientist at the University of Tokyo in 1989 and as the Director of the Material Processing and Manufacturing at the NSF from 1991-93. In 1976, he co-founded and served as Director of Engineering for Zoom Telephonics, Inc., a manufacturer of advanced telephone dialers and modems with annual sales in excess of $70 million.

Dr. Kramer has received the F.W. Taylor Medal of the International Institution for Production Engineering Research. The Blackall Award of the American Society of Mechanical Engineers (ASME) and the R.F. Bunshah Award of the International Conference on Metallurgical Coatings for his research work in tool wear modeling, tool material design and wear coating development. He holds 3 patents in hard coating, metal-ceramic composite, and solid lubricant technologies, has published in excess of 30 technical papers and has consulted extensively with industry.

VII. APPENDIX C.

CURRENT US-CHINA COOPERATIVE ACTIVITIES

National Institute of Standards and Technology, Commerce Department

In 1979, the Government of the United States of America and the Government of the People's Republic of China (PRC) launched a new program for scientific and cultural cooperation. Under the auspices of that program, the U.S. Department of Commerce and the State Bureau of Metrology signed a Protocol for cooperation in the fields of standards and metrology. Cooperation under that Protocol continued for ten years.

In 1988, with the passage of the Omnibus Trade and Competitiveness Act, it became a requirement for the U.S. to consider intellectual property protection in its international science and technology relationships. As a result, in 1989, the umbrella Science and Technology Agreement, as well as the Standards and Metrology Protocol expired as the U.S. and PRC continued to disagree on intellectual property issues. In 1991 our two countries reached agreement on provisions for the protection of intellectual property in our scientific relationship and a new Science and Technology (S&T) Agreement was signed. At that time, the National Institute of Standards and Technology (NIST) and the State Bureau of Technical Supervision (SBTS) began to explore the possibility of renewing cooperation in metrology and standards under the auspices of the S&T Agreement. A new Standards and Metrology Protocol was signed in January of this year.

The Standards and Metrology Protocol provides a framework for cooperation in such fields of metrology and related fundamental and applied sciences as: measurement and standards for the basic physical sciences; standards and measurement procedures for chemistry; protocols and standards for electronic data processing; building technology; materials measurements and standards; applied mathematics; and other fields as mutually agreed. Cooperative activities could include exchanges of scientific and technical information, researchers, samples and materials, as well as joint research and development. Under this Protocol, PRC researchers from the SBTS can participate in research activities at NIST in areas of mutual agreement. The duration of each scientist's visit to NIST can be no less than six months nor more than two years unless mutually agreed. In addition, unless otherwise agreed, the sending side is responsible for all travel expenses, including international airfare, subsistence and local ground transportation.

Based on the principle of equality, reciprocity and mutual benefit, cooperation in the field of metrology and related fundamental and applied physics have taken place. The cooperation takes many forms as exchanging and provision of information on metrological developments, organizing jointly supported seminars and short-term visits by senior staff members; exchanging and provision of testing samples, standard reference materials, reference data and components; conducting intercomparison of primary standards.

An incomplete figure shows that since the renewal of the Protocol in 1985, over 50 people from NIST have been invited to China for working visits, scientific exchange, and short-term technical consultancy; in the meantime, over 80 people from the Chinese side have been sent to NIST for technical visits, joint research, and seminars, covering general measurement technologies related to fundamental metrology in such areas as electricity, dimensional measurement, photometry as well as the industrial measurement standards and testing technology in high and new technology fields such as radio microwave measurement, the dimensional measurement for microstructure of the large scale integrated circuits (LSIC). Among the many important cooperative achievements, a few examples are given as follows:

1. Mr. Gao Jie, a research fellow from the China National Institute of Measurement and testing Technology conducted a project on the Josephson's Array Voltage Standard in collaboration with his American colleagues at NIST. He investigated the problem of microwave response caused by the junction array from which its voltage was increased to 10 V and reached the world's highest level. His American Collaborator was awarded the gold medal by U.S. Department of Commerce accordingly. Currently the voltage standard is being widely used to calibrate high precision digital voltmeters by the U.S. industry.

2. Mr. Guo You-Guang, a research fellow from the China National Institute of Metrology was invited to the NIST Boulder Laboratory where he worked on a transportable absolute gravimeter. He dedicated all his experience to improve the design of interferometer and falling objects of this third-generation gravimeter. The measuring accuracy of the absolute gravimeter was increased by several orders of magnitude and reached the world advanced level. At present, the gravimeter has been used in the United State, Japan and four other counties in geodesy, geophysics, geological prospecting and gravity measurement.

3. Mr. Tong Guang-Qiu, a young scientist from the China National Institute of Metrology worked at NIST and successfully developed a wide-range data acquisition system with fast-speed and high accuracy. He also put forward a correction method for the Malkov's estimated value in the non-singular zone and its measuring precision was increased by eight times. At the same time Mr. Tong solved the key problem of an audio frequency power standard developed by NIST. At present this standard has been widely used in industrial automatic control systems, computer interface and data acquisition systems. It was awarded the U.S. R&D 100 Invention Prize.

These examples demonstrate that such cooperation is beneficial to both sides. In May 1994, a seminar on strategic development of metrological technology was held jointly with NIST in the United States.

On the Chinese side, with the on-going effort to establish a market economy in China and entry into the international trade arena, the need for measurements and standards, both domestic and foreign, is greater than ever before. The development of high technologies requires newer and more precise measurement techniques. At the same time, the development of international trade and economic relations requires the Chinese national measurement system to be compatible with existing standards in the world. In this respect, cooperation between the Chinese and the United States on measurements and standards is an opportune event.

Under the existing protocol, the following items are being planned:

1. Exchange visits by senior staff members to make acquaintance with each other's national measurement systems, research activities and technology levels as well as the management of national quality awards.

2. Continued dispatch of 4 - 6 middle-aged scientists to NIST for joint research, development of measurement standards and automatic testing technology in the high-tech fields, such as: cryogenic measurement technology and devices for establishing low temperature standards below 1 K; Cesium clock with optical pumping technology, and the primary standards of piston gas flow.

3. Inviting NIST senior staff from offices of technical service, standards, codes, and information to China to lecture on the U.S. Government standards policy, national laboratory accreditation scheme, and therefore exploring the possibility of mutual recognition of each other's laboratory assessment systems. In addition, a Chinese certification delegation is expected to visit the U.S.A. to become acquaintanced with conformity assessment systems.

4. Continuation of the intercomparisons of primary measurement standards such as of those of large force and pressure, and exchange of equipment and instruments that are separately developed by each other's catalogues; jointly set up database of reference materials.

Currently, U.S. manufacturers interested in exporting their products to China must adapt those products to meet with Chinese standards. It would be a great benefit to the United States industry if China would accept international standards and conformity assessment practices. It is hoped that this Protocol will provide a basis for an expanded relationship with China in the field of Standards development.

Polymer blends: The NIST Polymer Blends and Processing Group has an on-going collaboration with East China University of Chemical Technology (Shanghai, China) and Fudan University (Shanghai, China) for the past six years on the subject of using hydrogen bonding interaction to promote the miscibility of polymer blends and to control the phase separated morphology.

During the past six years, three Chinese guest scientists have visited NIST for various lengths (Professor Manjun He for 6 months, Mr. Yi Feng for 2 years and Mr. Shuiqiang Li for 2 years by April 1996). Also Professor Ming Jiang for a short (2 days) visit and Mr. Chunlin Zhou is scheduled to come for 1 year starting in June, 1995. Dr. Charles C. Han visited both East China University of Chemical Technology and Fudan University for two weeks in February, 1994.

For the past six years, the collaboration has been directed towards the hydrogen bonding in polymer blends. The synthesis skills of our Chinese collaborators complement well with the measurement and theoretical capability at NIST. Six scientific papers have been published and three U.S. patents have been granted on the subject of "Hydrofluoroalkyl-Substituted Styrene and Polymeric Compositions Containing Same" between 1993 and 1994.

The current collaboration is directed toward the polymer blends compatibilization with the use of block copolymers which contains hydrofluoroalkyl substituted styrene co-monomers as interfacial modifier.

Some planned and controlled expansion of this collaboration into other areas such as LPC, composites, and functional polymers could be mutually beneficial. However, proper choice of Chinese collaborators and research institutes is important in order to have a successful program.

The National Science Foundation

The National Science Foundation (NSF) is an independent agency of the Federal Government, established in 1950 to promote and advance scientific progress in the United States. The Foundation does this primarily by sponsoring scientific and engineering research and education. NSF does not itself conduct research.

NSF encourages U.S. participation in international science and engineering activities that promise substantial benefits to U.S. researchers and educators. It seeks to expand and facilitate the international aspect of NSF-funded projects by promoting new partnerships between U.S. scientists and engineers and foreign colleagues, supporting joint seminars, workshops and planning visits to foster such partnerships.

NSF participates in five of the government-to-government protocols on US-China cooperation in science and technology. Specific areas covered under the protocols include earth sciences, atmospheric sciences, marine sciences, earthquake engineering, and basic sciences (covering all fields of basic research normally supported by the NSF). The NSF US-China Cooperative Research Program, located in the Division of International Programs, is dedicated to supporting collaborative research with China. Partners in China include the Chinese Academy of Sciences, the National Natural Science Foundation, the State Education Commission and the Academy of Social Sciences. Through this program, US investigators may apply for support to conduct research with Chinese partners. For NSF, this program is largely driven by the needs and interests of the US scientific community, and by the opportunities to advance US research interests through work with China. In addition to the US-China Cooperative Research Program, proposals for research with or in China may be considered by most programs throughout the NSF, assuming there is a cogent scientific justification for involving China in the research effort. Most international research projects result from personal interactions between U.S. and foreign researchers. The researchers prepare research proposals for consideration by the research funding agencies of their respective countries for funding of the component of the research that is performed in each country.

The agreement in basic sciences, renewed in January 1995 for five years, covers all fields of science and engineering supported by the Foundation and NSF has been actively supporting joint research efforts with China in materials under this agreement. The Protocol provides an important framework for collaborative research efforts. Projects sponsored jointly by NSF and a Chinese counterpart under the Protocol enjoy official status in China, providing expedited access to research sites, access for the Chinese co-PI to funds targeted for international work by the Chinese government, official intervention by China's central government when problems arise, and mobilization of operational and scientific support for projects carried out in China. NSF has supported hundreds of collaborative projects since the early 1980's. In materials science, collaboration between Chinese and American researchers has taken advantage of complementary expertise and instrumentation to enhance research efforts in both countries since 1980. Chinese expertise in molecular simulation studies, for example, has contributed to advances in programs for modeling polymer structure, both crystalline and amorphous, with the results of one collaborative project having been commercialized in the US. Collaboration in materials sciences is expected to increase given the funding emphasis of the Chinese government on materials science and engineering projects.

NSF expects to continue to support meritorious collaborative projects between US and Chinese scientists, and to draw on the emerging strengths of the US-educated Chinese scientists who have returned to China as partners in collaborative research. Expansion of access to Internet within China is expected to greatly facilitate communication among the two scientific communities. Issues of data exchange, research funding, and access to field sites will be monitored by NSF to ensure smooth progress of joint projects.

NSF-Supported US-China Projects in Materials

(These projects all received travel support from the NSF China Program)

B. McCoy	SUNY, Stonybrook	Studies of Model Systems in Statistical Mechanics and Quantum Field Theory	$ 72,000
S. Schlick	U. of Detroit	Effect of Ions on Polymer Properties	$ 90,000
D. Nelson	Harvard U.	Theoretical Problems in Condensed Matter and Statistical Mechanics	$125,000
D. Vanderbilt	Rutgers U.	Bulk and Surface Structural Properties of Materials	$ 75,000
M. Greenblatt	Rutgers U.	New Solid Electrolytes with Dispersed Conducting Salts in Microporous Solids	$ 23,503
E. Ma	Louisiana St. U.	Formation and Thermodynamic Stability of Metastable Phases in Selected Metals and Alloy Systems	$ 44,270
T. Howes	U. Connecticut	Research Planning Visit to Precision Manufacturing Centers	$ 13,250
T. Hsu	U. Houston	Framed Shearwalls in Earthquakes	$ 72,635
C-H. Wang	U. Nebraska	Dynamic Light Scattering Studies of Segmental Motion and Viscoelasticity in Polymers	$ 84,000
A. Efros	U. Utah	Study of Inhomogeneous State of 2-Dimensional Electron Quantum Liquid	$ 70,000
D. Heiman	MIT	Optical Spectroscopy of Quantum-Confined Electrons at High Magnetic Fields and Low Temperatures	$ 55,000

R.Westervelt	Harvard U.	Electron Transport in Graded GaAs/AlGaAs Heterostructures	$ 60,000
H. Jiang	Kansas St. U.	Charge Storage and Persistent Photoconductivity in II-VI Semiconductor Alloys	$ 51,000
M. Cohen	UC, Berkeley	Theoretical Solid State Physics	$260,000
J. Tang	U. New Orleans	Postdoctoral Fellow: Studies of Nanocomposite Materials with Giant Magnetoresistance	$ 11,800
S. Liu	Florida Inst of Tech	Reliability of Microelectronic Packaging and Interconnects	$ 2,300
J. Ghaboussi	U. Illinois	Neural Networks in Materials Modeling and Computational Mechanics	$ 38,926
J. Walker	Johns Hopkins U.	MBE Studies of Magnetic Surfaces, Interfaces, Superlattices and High Tc Superconductors	$ 80,000
Hutchinson	CO Sch of Mines	Metallogenic Evolution of Major Tin Fields	$ 9,109
Y-L. Hsieh	UC, Davis	Polymerization and Processing of Ultra-high Molecular Weight Polyethylene Terephthalate	$ 59,145
S. Hsu	U. Massachusetts	Structure and Defomation Behavior of Model Elastomers	$ 27,000
J. Bell	U. Connecticut	Polycarbonate/Epoxy Copolymers and Coating Systems	$ 21,434
T-Y. Tien	U. Michigan	Phase Equilibrium Studies in Silicon Nitride-Metal Oxide Systems	$ 27,920
D. Whitten	U. Rochester	U.S.-China Workshop on Photoinduced Charge Transfer	$ 20,500
S. Sarma	U. Maryland	Anyons, Fractional Quantum Hall Effect and Localization	$102,000
L. Chang	IBM	21st International Conference on the Physics of Semiconductors	$ 10,000
Williamson	CO Sch of Mines	Atomic Scale Structure of DX Centers in GaAlAs Semiconductors	$ 83,000
		Total	$1,513,792

DEPARTMENT OF ENERGY

Formal interactions between the Department of Energy and China with regard to science and technology (S&T) are covered by two bilateral umbrella agreements between the U.S. and China, both led by the State Department. The Civil Nuclear Agreement was signed in Beijing in 1985 but has not yet entered into force due to nonproliferation issues. The Science and Technology Agreement, on the other hand, which was signed in 1979 is currently very active. DOE is responsible for four of the 30 protocols under the S&T Agreement.

High Energy Physics (HEP) Accord

The High Energy Physics Accord which was signed in 1979 is between DOE/Energy Research (ER) and the Chinese Academy of Sciences (CAS)/Institute of High Energy Physics. Under the High Energy Physics Accord, annual joint management meetings are conducted in alternate countries. The Beijing Electron-Positron Collider (BEPC) was brought into operation in 1988 and is open for experiments by scientists from the international scientific community.

Nuclear Physics and Magnetic Fusion Protocol

The Nuclear Physics and Magnetic Fusion Protocol between DOE/ER and the State Science & Technology Commission was signed with the S&T Agreement in 1987 and will be coterminated with the S&T agreement. Although nuclear physics collaborations continue between scientist on both sides under the Nuclear Physics and Magnetic Fusion Protocol no joint projects have been initiated. Cooperation on the Magnetic Fusion Project which was dormant for a few years after the Tiananmen Square is becoming active again.

At a meeting with Secretary Hazel O'Leary in April 1994, the Chinese expressed a desire to join the International Thermonuclear Reactor (ITER) program. Secretary O'Leary indicated that Chinese participation is subject to acceptance by the three other ITER partners: the European Union, Russia and Japan. Under Secretary Curtis, during a recent trip to Beijing, informed the Chinese that the subject is under consideration. Chinese officials have revealed that one purpose of the Chinese fusion program is to develop the concept of a fission-fusion hybrid reactor which could produce plutonium for its civilian reactors.

Fossil Energy Protocol

The Fossil Energy Protocol between DOE/Fossil Energy (FE) and the Ministry of Coal Industry (MOCI) was signed in 1987 and co-terminates with the S&T Agreement. The last joint review meeting on the Fossil Energy Protocol was conducted in 1991 in Washington. DOE plans to hold a joint review meeting in 1995 in Beijing or in the U.S.

There are five annexes for technology cooperation under the protocol:

1. Coal Preparation and Waste Stream Utilization between DOE/Pittsburgh Energy Technology Center (PETC) and China Central Coal Mining Research Institute (CCMRI);

2. Atmospheric Fluidized Bed Combustion (AFBC) of Coal between DOE/Morgantown Energy Technology Center (METC) and China National Coal Corporation (CNCC);

3. Carbon Dioxide Induced Climate Change Research between DOE/ER and CAS/Institute of Atmospheric Physics and Institute of Geography;

4. Clean Coal Technology between DOE/FE and SSTC;

5. Coal-Fired Magnetohydrodynamic (MHD) Power Generation between DOE/FE and CAS/Institute of Electrical Engineering (IEE).

A sixth annex, Coalbed Methane Recovery and Utilization between DOE/FE and MOCI, was signed this year. Collaborations in several other potential fossil energy cooperative activities with China are being actively explored, including spontaneous combustion of coal underground.

According to T. D. Atwood (FE/Office of Clean Coal) there are 12 annexes to the protocol; however, Annexes 5 to 8 have never been signed. The Annex for Clean Coal Technology is the most active. FE considers a major part of its task as helping the U.S. to transfer clean coal technology to China. A good market exists for coal gasification equipment not only for energy generation but also to provide chemical feedstock. Texaco is heavily involved in developing the clean coal technology markets. The Chinese are interested in using the output of coal gasification plants to provide feedstock for ammonia synthesis. Existing ammonia generation plants are old and require low pressure (500 psi) inputs. The Chinese are interested in the possibility of achieving input pressures of 1200 to 1500 psi for improved efficiency for which improved values and flanges will be required.

<u>Energy Efficiency and Renewable Energy Protocol</u>

The Energy Efficiency and Renewable Energy Protocol between DOE/Energy Efficiency and Renewable Energy and the SSTC was signed by Secretary O'Leary on February 23, 1995. Activities are underway at DOE to implement the 11 annexes signed as part of this protocol:

1. Energy policy development
2. Information exchange
3. Communication and outreach
4. District heating
5. Cogeneration
6. Energy efficient building demonstration
7. Electric motor and motor systems
8. Industrial process controls
9. Lighting
10. Amorphous core transformers
11. Finance.

The goal is to have action plans drafted for each of these areas by the end of May, 1995. Private/public sector teams have been selected for the highest priority energy efficiency items, and team and team leader information has been sent to China. A China/U.S. working group is to be established to coordinate joint energy efficiency activities and develop action plans for initiatives. Work is ongoing with appropriate Chinese organizations to verify progress on energy efficiency and to advocate programs.

Office of Basic Energy Sciences

The Energy Research/Office of Basic Energy Sciences has two informal interactions ongoing with Chinese scientists. Dr. Oscar Manley (Engineering and Geosciences) attended the Conference on Inertia Manifolds and Numerical Methods in Xi'an in June to give an invited lecture. He also visited the Chinese Natural Sciences Foundation (CNSF) and CAS where he gave invited lectures.

Dr. Yok Chen (Materials Sciences) has an active informal collaboration with Professor Xiang-fu Zong and his group at Fudan University in Shanghai. While at Oak Ridge National Laboratory, Chen began the collaboration with Professor Zong on the effects of radiation on induced electrical degradation and enhanced conductivity in Al_2O_3. U.S. researchers at Los Alamos National Laboratory and at the Idaho National Engineering Laboratory who have collaborated with Chen in this area are also involved in this interaction with the Fudan group. Four papers have been published from this collaboration, and a fifth one is under preparation.

Oak Ridge National Laboratory (ORNL)

ORNL has no separate formal agreements in materials R&D with any Chinese Institute outside of the Department of Energy Protocols. Within the Metals and Ceramics Division, we have had a number of scientists from PRC here for various periods of time (e.g., ~10 visiting scientists per year, 6 postdoctoral candidates, 8 university students).

Current activities within the Metals and Ceramics Division include several informal collaborations:

Study of Environmental Embrittlement in Ni_3Al. Contact Person:Professor X. J. Wan, Director of Institute of Materials Research, Shanghai University of Technology, Shanghai. The ORNL portion of this collaborative research is supported by the Department of Energy, Office of Basic Energy Sciences Program.

International workshop on ordered intermetallic alloys and composites to be held in Beijing on June 25-30, 1995 under joint sponsorship. Contact Person: Professor G. L. Chen, Director of State Key Metal Laboratory, Beijing University of Science and Technology, Beijing. Contact Person within Metals and Ceramics Division, ORNL is Dr. D. F. Craig, Director, Metals and Ceramics Division, Oak Ridge National Laboratory, P. O. Box 2008, Oak Ridge, Tennessee 37831-6132, Tel. 615-574-4065 Fax. 615-574-4066 and Dr. L. L. Horton, Associate Director, Metals and Ceramics Division, Tel. 615-574-5081

No formal plan exists at this time and no mechanism for formal collaboration in place at this time. Potential Areas or Topics for Collaboration Under a New Agreement are:

A. Deformation and fracture of intermetallics

B. Fracture mechanisms in and toughness of $Nd_2Fe_{14}B$ magnetic materials
C. Processing of shape- memory alloys
D. Physical metallurgy of refractory alloys
E. Effect of rare-earth elements on the properties of high temperature structural alloys
F. Interface structure and properties as related to the properties of ceramics and metallic alloys
G. Fracture resistance of ceramics and toughening mechanisms
H. Phase equilibria in the silicon nitride system and oxynitride glass properties
I. Creep and fatigue behavior of ceramics and composites at elevated temperatures
J. New metallic/intermetallic binder phases for hard metals (i.e., WC TiC, etc.)
K. Wear behavior of ceramics and metals
L. Processing of ceramics and metals by gelcasting and microwave sintering
M. Microstructural design of ceramics
N. Mechanisms of anisotropic grain growth in ceramics and the influence of impurities.

THE LAWRENCE BERKELEY LABORATORY

Apart from informal interactions between scientists in their respective countries, few official collaborations currently exist between the Lawrence Berkeley Laboratory (LBL) and the People's Republic of China; of these, none are directly associated with materials research. However, two projects are presently active, namely: the LBL China Energy Project and the China-US collaboration on high resolution geophysical imaging. These are described in some detail below.

LBL China Energy Project: *Background and History:* In 1987, Department of Energy (DOE) Policy requested that LBL co-organize (with John Hopkins University) a workshop/conference on energy markets in Nanjing, China. The workshop took place in 1988 and generated a great deal of interest in the establishment of a collaboration between the U.S. and China on energy efficiency.

Current Activities: The major themes of this project have been energy efficiency and measures to reduce carbon dioxide emissions in China. These themes have been pursued through analysis projects, development of data books, support for the creation of a new institution to promote energy efficiency in China - the Beijing Energy Efficiency Center, and the joint U.S./China energy efficiency business activities, especially in co-generation of power and heat and in lighting projects. Specific projects and objectives are as follows:

- Analysis of opportunities for increasing efficiency of energy supply and end use.
- data collection on all phases of China's energy system.
- Collaboration to improve energy efficiency programs and investments.
- Project to assist the energy community in China to design and carry out needed reforms in the energy sector, and to incorporate energy efficiency aggressively in its program for adressing global environmental issues.
- Support for the Beijing Energy Efficiency Center, a new institution created by LBL and the Pacific Northwest Laboratory with the Energy Research Institute of China's State Planning

Commission to promote energy efficiency in China.

- Program to train Chinese energy experts in methods of energy demand modeling, utility planning, and appliance efficiency standard development.

Since 1988, the Program has operated at $300K per year. Until FY 1994, the bulk of the funding was from the Office of Environmental Analysis within DOE's Policy Office; since 1994, funding is from DOE's Office of Energy Efficiency and Renewable Energy and the Office of Fossil Energy. In addition, supplemental funding has been obtained from several sources, including the National Institute of Global Environmental Change, internal LBL funds, DOE's Office of Intelligence, and the Asia Development Bank.

This funding supports Mark D. Levine, Program Leader, who devotes 10 to 20% of his time to this activity, a full-time post-doctoral researcher (Chinese) and a full-time graduate student research assistant.

Contact Person: Mark D. Levine, Program Leader, Energy Analysis Program, Lawrence Berkeley Laboratory, MS 90-4000, University of California, Berkeley, CA 94720, USA; *tel:* (510) 486-5238.

Existing Plan for the Future: Future plans, should the level of effort be expanded, include:

- joint efforts with Chinese counterparts to commercialize energy efficiency technologies, including partnership with private U.S. firms, in areas such as cogeneration, lighting and residential appliances, and industrial process technologies.
- studies to support new capital investments in energy efficiency projects in China, including involvement in possible joint implementation projects.
- in-depth set of case studies and analysis of decision making in the Chinese cement industry.
- project management of a major project to develop a new, energy-efficient, non-CFC refrigerator for China, including the production, marketing, and sale of the refrigerator in collaboration with a Chinese manufacturer.

Collaboration for high-resolution geophysical imaging: *Background and History:* LBL has been engaged in research into geophysical imaging for the past decade under the primary sponsorship of DOE. This particular collaborative program grew out of this work and the mutual interests of the Bureau of Geophysical Prospecting in the U.S. and the China National Petroleum Corporation in China.

Current Activities: The program involves a joint collaborative effort between LBL, the Bureau of Geophysical Prospecting and the China National Petroleum Corporation to identify the critical issues associated with geophysical imaging for the characterization of hydrocarbon reservoirs essential for enhanced oil recovery. The program is focused on discerning which techniques are currently available to resolve these critical issues and, if not available, to seek solutions. A successful example is the development of "q-domain" imaging, involving the transformation of diffusive electromagnetic fields to wavefields, such that the electrical conductivity can be obtained by traveltime tomography in crosshole configuration; this technique can also be used to image seismic velocity. Specific projects and objectives are as follows:

- Exchange of ideas for obtaining high-resolution imaging of geophysical parameters, such as seismic velocity and electrical conductivity.
- Facilitation of suitable environments for exchanging ideas through visits to laboratories involved in the collaboration. In particular, Chinese scientists are given access to LBL's computing and research facilities, and scientists from LBL to the Bureau of Geophysical Prospecting's research facilities.
- Characterization of the geology of the producing oil fields in China, including field trips by LBL scientists to these regions.

The Program is funded from FY1994 through 1998 at a budget of $37,450 per year. Funding is provided to LBL from the China National Petroleum Corporation, P.O. Box, 766, Liu Pukang, Beijing, through a subcontract with the Bureau of Geophysical Prospecting. This funding supports Ki Ha Lee, Program Leader, and a staff scientist Ganquan Xie, in the Earth Sciences Division of LBL.

Contact Person: Ki Ha Lee, Program Leader, Subsurface Geosciences Program, Earth Sciences Division, Lawrence Berkeley Laboratory, MS 50A-1119, University of California, Berkeley, CA 94720, USA; *tel:* (510) 486-7468.

Existing Plan for the Future: This is a newly instituted program which is scheduled to run for 4 years.

NATIONAL AERONAUTIC AND SPACE ADMINISTRATION (NASA)

Protocol on Space Cooperation:

NASA and China's State Science and Technology Commission (SSTC) exchanged a draft text of a Space Protocol in 1987. Further negotiation was put on hold pending the conclusion of the IPR Annex to the overall US/PRC Science and Technology Agreement. Although the IPR Annex to the S&T Agreement was signed in May 1991, NASA and the Chinese government have not resumed discussions on the Space Protocol.

Protocol on Aeronautics Cooperation:

NASA signed a Protocol on Cooperation in Aeronautical Science and Technology with the Chinese Aeronautical Establishment (CAE) in 1983. No activity took place under the agreement until the IPR Annex to the protocol was signed in 1986. The agreement was signed by Dr. Jack Kerrebrock, NASA Associate Administrator for Aeronautics and Space Technology and Zhang Chi, Vice President of CAE. The protocol expired in 1991.

While the Aeronautical Protocol was in effect, NASA and CAE held four symposia and agreed to conduct joint research in (1) fatigue and fracture mechanics and (2) wind tunnel wall interference correction. The final meeting of fatigue and fracture mechanics effort was held in August 1989. NASA and CAE also developed a schedule and formats for text data exchange for the wind tunnel wall interference correction study.

Letter Agreements:

Three letter agreements with China are currently in effect:

November 18, 1992, Agreement between NASA and the Chinese Academy of Sciences concerning cooperation in the Dynamics of the Solid Earth (DOSE) program. This agreement provides for cooperative activities with and the inclusion of Chinese stations in the existing worldwide Global Positioning System (GPS), Very Long Baseline Interferometry (VLBI) and Satellite Ranging (SLR) networks.

May 8, 1989, Agreement between NOAA and the State Meteorological Administration of China concerning cooperation in atmospheric science and technology. This agreement stipulates that NASA participates in the program in the same manner as NOAA. NASA's primary area of interest in this area is atmospheric chemistry. The Joint Working Group on Atmospheric Chemistry, which NASA has participated in, is meeting for the third time in August 1994 in China. At the first two meetings, each side agreed on a small number of areas in which cooperation should be pursued.

June 1994, agreement provides for Chinese participation in the Spaceborne Imaging Radar-C/X-Band Synthetic Aperture Radar (SIR-C/X-SAR) program. The first SIR-C/X-SAR flight was in April, 1994. The second flight took place in August 1994 on STS-68. Chinese researchers are among an international team of 49 science investigators that conducted the SIR-C/X-SAR experiments.

Additional Cooperation:

Three Chinese student experiments have flown aboard the Space Shuttle as part of the Get-Away-Special (GAS) small payload opportunity program. The first flew in January 1992, and the other two flew in September 1994.

The Chinese Academy of Sciences has recently reserved eight slots for GAS payload experiments, with the first due to be launched in late 1995.

VII. APPENDIX D.

CHINESE MATERIALS SCIENCES AND TECHNOLOGY PROGRAMS

On May 6, 1995, the Chinese Central Committee and State Council issued a Decision on Accelerating Scientific and Technological Progress. It affirmed a guiding technology policy principle which was formulated by the Chinese government sixteen years ago. In 1979 China's leader, Deng Xiaoping, declared "economic construction shall depend upon scientific research and technology, and that the latter will contribute to economic development."

The new policy deepens efforts since the mid-1980's to encourage scientific research institutes to become financially independent and to commercialize scientific discoveries. The Provisions on Technological Structural Reform, promulgated by the State Council in 1987, restructured the science and technology system with an intent to liberate the forces of technological innovation. Scientists were granted more employment mobility between research institutes. Integration of technology policy with economic development plans was to be achieved by close collaboration between scientific research and innovation in manufacturing.

Mature technical alliances between domestic electronics manufacturers and research institutes have successfully brought research results out of the laboratory and into production. Some manufacturers have developed internal research units, while many other research institutes now provide research services to state-owned enterprises and foreign-owned manufacturing entities in China.

This report contains a brochure prepared by the State Science and Technology Commission entitled "The Main Programmes of Science and Technology" in China. It introduces seven program groups. The degree of state funding and foreign participation allowed vary. Advanced materials science is one area within China's High Technology Development Program, also known as the 863 Program. Research undertaken by participants in this program is state funded. Foreign participation appears to be limited to government-to-government cooperation. The Measures for Management of Intellectual Property specifically concerns scientific results from this program. The Management Measures clearly indicate that the Chinese State owns the intellectual property rights in the discovery but the researcher has rights of use.

Foreign industrial research cooperation is currently being undertaken in several advanced technology sectors, but is primarily funded by the foreign party and not connected with any Chinese government research program. The private research objective is usually related to the firm's production joint venture activity in China or to development of professional contacts for future projects. The research and development objective is usually determined by the foreign party, as opposed to fitting it into a particular Chinese research and technology development program.

Review of Chinese technology policy and close comparison of the program objectives for the 863 Program and the Torch Program demonstrates that China has divided its programs according to certain phases of innovative activity and targets six technology areas: biotechnology, aerospace, information/telecommunications, manufacturing automation, energy, and advanced materials.

It would appear that the 863 Program concerns basic research in the above science fields, while the Torch Program is conceptualized as the vehicle for getting the research results out of the laboratory through development, and into production. The management measures for the 863 Program explicitly require the Chinese research institute to obtain approval from the Chinese government to license technology or to undertake cooperative exploitation of the research achievement with a foreign firm.

The literature which introduces various Torch Program projects clearly invites foreign capital and technical expertise. It also appears that the Chinese State has less interest in the intellectual property rights and only partial PRC government funding is available. The research institutes participating in the Torch Program are expected to seek foreign investment capital or local bank loans for expenses not covered by the PRC government science research grant.

The Torch Program and 863 Program are linked to China's scheme for development of an advanced technology industrial base. The Chinese central government has established 52 "science parks" or "high technology development zones (HTDZ)". Additional science parks have been established by provincial and municipal government levels. The science parks are located in zones surrounding leading research institutes and manufacturing entities with complimentary technical capabilities in Beijing, Tianjin, Xian, Shanghai, Wuhan, and Chengdu.

Firms interested in the Torch Program and science parks should refer to the Relevant Policies and Regulations on National High Technology Development Zones, promulgated by the State Council on March 6, 1991. These HTDZ Regulations specify the technology areas within which research must be conducted; confer authority on the research institute to engage in foreign trade; contain exemptions from certain taxes and import duties; authorize establishment of a bonded warehouse; and waives import license requirements for raw materials and component parts.

VII. APPENDIX D. 1.

THE MAIN PROGRAMMES OF

SCIENCE AND TECHNOLOGY

State Science and Technology Commission
People's Republic of China

FOREWORD

A common feature in the development of various countries in today' s world is that they all attach great importance to the formulation and execution of programmes and plans for developing science and technology and emphasize international exchange and cooperation in the field of science and technology. In which, Chinese government and many others play the most important roles. The State Science and Technology Commission is the top administration responsible for formulating and implementing China' s science and technology policies, strategies, guidelines, regulations, programmes and plans, as well as directing and coordinating scientific and technical activities in both national and local levels. Since 1980' s, following the strategic principle of "economic construction should rely on science and technology while the secentifie and technological efforts should be geard to serve economic construction", the state commission has organized Chinese R&D activities in three levels: The first is the programmes that serve the main battlefield of economic construction, including the Key Technologies R&D Programme, the Spark Programme, the National S&T Achievements Spreading Programme, the National Trial- Production and Appraisal Programme. The second is the programmes that promote the high-tech development and industrialization, including the "863" Programme and Torch Programme. The third is basic research programme, namely, the National Basic Research Prorities Programme. The implementation of those programmes has greatly enhanced and will continue to promote national productivity and Chinese comprehensive powers, as well as international cooperation and exchange.

The policy of reform and opening to the outside world has created an excellent social environment and physical conditions for China' s science and technology development. The purpose in giving our friends an overall account of how we are carrying out our science and technology development programmes is to welcome foreign governments, friends from all walks of life in home and overseas, and our compatriots from Hong Kong, Macao and Taiwan to actively support and participate in China' s programmes for developing science and technology and contribute to China' s modern economic construction and the world' s civilization and progress.

Department of Planning
the State Science and Technology Commission
June, 1992

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國家科技攻關計劃

KEY TECHNOLOGIES R&D PROGRAMME

組織科技攻關是中國政府的戰略布署。爲貫徹“經濟建設必須依靠科學技術，科學技術工作必須面向經濟建設”的戰略方針，1982年開始組織實施國家科技攻關計劃。“攻關”計劃的宗旨是解決兩方面的問題：一是針對當前國民經濟和社會發展急需要辦的大事，需要科技發揮先導作用解決的重大課題；二是抓對國民經濟和社會發展將產生重大影響，帶有方向性、基礎性、綜合性的重大課題，集中力量攻關。

“攻關”計劃實施八年來，在科技促進農業發展、傳統工業的技術更新、重大裝備的研制、新興領域的開拓以及高新技術在生態環境和醫療衛生等方面的應用開發都取得了大量成果；解決了一批國民經濟和社會發展中難度較高的技術問題，對我國主要產業技術發展的方向和產品結構的調整已經并且必將繼續發揮重要的先導作用；爲重點建設、技術改造提供了一批重要的技術和裝備；發展了一批適合我國資源特點的新技術；開發了一大批更新換代的新產品；在若干高技術領域取得了重大突破；同時凝聚和造就了一大批科技人才，穩定了我國科技的主力軍隊伍，積累和增强了科技工作繼續開拓前進的物質技術基礎，使我國科技工作的整體水平有了較大提高。

Arranging for tackling key technical problems is a strategic plan of Chinese government. The National Key Technologies R&D Programme was first implemented in 1982 to carry out the strategic policy of "economic construction must rely on science and technology, while science and technology must serve the needs of economic construction". The aim of the programme is to pool financial and well-trained human resources to the technologies that is critical to the national economy and social development at present and that will guide and greatly influence the development of the national economy and society in future.

After eight years' operation the programme has made great achievements in promoting agricultural development, renewing traditional industries, developing major equipment, exploring new areas, and applying new and high technologies in the fields of ecology, environment, medical treatment, and health. The programme has been playing an important role in orienting the technological development of major industries, solved a batch of bottleneck technical problems in the process of national economic and social development, provided essential instruction and equipment to key construction and technical innovation activities, developed new technologies suitable to the features of local resources and new generations of products, obtained major results in several high-tech areas, gathered and trained a large number of scientific and technical personnel, stabilized the country's scientific and technological work force, laid and strengthened the practical technological foundation for the further development of scientific and technological undertakings, and raised the level of the country's scientific and technological work as a whole.

豐碩成果

Great Achievements

"六五"國家科技攻關計劃，安排了 38 個項目，1450 個專題，國家撥款 15 億元，參加"攻關"計劃的科技人員近 10 萬人，取得 3896 項重要科技成果，已用于重點建設、技術改造和工農業生產中的有 3165 項，直接經濟效益達 127 億元。繼"六五"科技攻關取得很大成績之后，"七五"科技攻關無論從投人的規模和取得的成果看又有重大發展。其主要表現在以下幾個方面。

·"七五"科技攻關經費仍以國家撥款爲主，同時注意多渠道籌集。"七五"期間科技攻關經費總投人 64.5 億元，其中國家科技攻關撥款 31 億元占 48%，單位自籌 17.2 億元占 26.7%，銀行貸款 16.3 億元占 25.3%。

·"七五"科技攻關匯集了我國科技戰綫一大批優秀的科技人員，人員素質高，科研能力强。"七五"期間參加科技攻關的科技人員近 13 萬人，其中科學家、工程師占 81.2%；技術員占 13.4%；其他人員占 5.4%。從專題技術負責人情况看，具有高級技術職稱的占 86.9%。

·成果數量大，水平高。"七五"科技攻關共獲得專題成果（包括子專題成果）10462 項。其中達到或接近八十年代國際水平有 6068 項占 58%；與國内技術現狀對比分析，屬國内領先水平有 4163 項占 39.8%，屬填補國内空白的有 4112 項占 39.3%。另外，"七五"科技攻

During the Sixth Five- year Plan the programme engaging nearly 100000 scientific and technical personnel organized 38 projects, subdivided into 1450 specific topics. The state grant for the programme totaled 1. 5 billion yuan. There were 3896 items of major scientific and technical advance, 3165 of which were applied to key construction projects, technical innovation, and industrial and agricultural production, resulting in direct economic benefit of 12. 7 billion yuan. The great success of the programme during the Sixth Five- year Plan led to its further developedment during the Seventh Five-year Plan in terms of both investment and achievement, as shown in the following :

——During the Seventh Five-year Plan the budget for the programme was still dominated by a state grant, but funds from other sources were also sought. The total input for the programme was 6. 45 billion yuan, of which 3. 1 billion yuan, or 48 percent, was granted by the state, 1. 72 billion yuan, or 26. 7 percent, was raised by implementing units, and 1. 63 billion yuan, or 25. 3 percent, was loaned by banks.

——During the Seventh Five-year Plan, the programme gathered a large number of highly educated staff in the field of science and technology who were very strong in scientific research. Over the period, 130000 scientific and technical staff took part in the programme, 81. 2 percent of that is scientists or engineers and 13. 4 percent is technicians. Among the technical managers for specific topics 86. 9 percent were senior technical staff.

——A great many high-level achievements resulted. Achievements in specific topics, including subtopics, totaled 10462 items, 6068 of which, or 58 percent, reached or approached international standards of the 1980s, 4163 of which or 39. 8 percent, were in leading positions in home market, and 4112 of which, or 39. 3 percent, entered virgin territory in China. In addition, 334 patents were granted, among which

關獲得國家專利 334 件，其中發明專利 160 件、實用新型專利 172 件、外觀設計 2 件。截止 1990 年底統計，“七五”期間科技攻關成果共獲得國家自然科學獎 7 項，國家發明獎 28，項，國家科學技術進步獎 120 項，部級科學技術進步獎 620 項，省級科學技術進步獎 547 項。

160 were invention patents, 172 were new practical design patents and two were appearance design patents. By the end of 1990 seven items had received National Natural Science Awards, 28 National Invention Awards, 120 National Science and Technology Progress Awards, 620 Ministerial Science and Technology Progress Awards, and 547 Provincial Science and Technology Progress Awards.

·建立了一大批先進的科研基礎設施。通過“七五”科技攻關建成的試驗生產綫 1339 條、工業試驗基地 872 個，農林試驗基地 2513 個，各類專用數據庫 42 個，國家農作物種子資源庫 1 個。這些基礎設施的建立和完善大大加强了我國科學研究的后勁。

—— A number of advanced basic facilities supporting scientific research were established and improved, including 1339 pilot production lines, 872 industrial test bases, 2513 agriculture and forestry bases, 42 data bases for special purposes and one national seed base for agricultural plants.

·科技攻關成果的應用及轉化率高，經濟效益顯著。“七五”期間科技攻關實際應用的專題成果 5162 項，直接轉化爲生產力的專題成果 1826 項，應用及轉化率爲 74.9%。“七五”期間科技攻關獲得直接經濟效益 406.8 億元，其中簽訂科技攻關成果轉讓合同 1418 項，成交額 9386 萬元，占總效益 2‰。“七五”科技攻關專題經費實際支出 59.2 億元，應用專題成果新增固定資産投資 14.8 億元，二者與直接經濟效益的投人産出比爲 1 : 5.5。

—— A large portion of the achievements were applied and transformed, resulting in remarkable economic benefits. During the Seventh Five-year Plan the application or transformation rate of achievements was 74.9 percent, with 5162 items practically applied and 1826 items transformed directly into the productive force, resulting in about 40.68 billion yuan in direct income. Some 1418 items were contracted for transfer, the transactions amounting to 93.86 million yuan, or 0.2 percent of the total income. The total expense for the specific topics of the programme during the Seventh Five-year Plan was 5.92 billion yuan and the total input for newly acquired fixed assets, as required in applying the achievements of the specific topics, was 1.48 billion yuan. The input/output ratio of the total input to the direct income was 1:5.5.

再攀高峰

Further Development

“八五”科技攻關計劃是在“七五”的基礎上，根據國民經濟和社會發展需要而安排的。“八五”期間，科技攻關計劃的要點是：

1. 繼續堅持把農業科技攻關放在首位。我國農業生産存在的主要問題：一是生産水平不

The programme in the Eighth Five-year Plan was planned according to the needs of the national economy and social development. The major points are as follows:

1. To continue to tackle agricultural technical problems as first priority. The major problems in

高；二是有限耕地中，中低產田比重大，占三分之二。針對這種情況，“八五”農業科技攻關重點應抓好兩方面的工作：

・主要農作物良種的培育，建立健全從育種研究到良種繁育推廣的一條龍服務體系；

・中低產區域的綜合治理研究，大幅度提高單產水平。

選育和推廣良種是一項投資少、見效快、效益高的重要農業增產措施。“八五”科技攻關的目標是選育出商品化新品種 200 個以上，要求比主栽品種增產 8－10%，育種研究要利用雜種優勢和核不育的育種方法及技術，在水稻亞種間雜交及小麥、谷子、棉花、油菜、蔬菜的雜交利用等方面取得突破。

中低產區域是農業增產潛力最大的地域，“八五”科技攻關要依托原有的試驗點（站），加强研究的深度。在總結“六五”和“七五”中低產田綜合治理的經驗教訓基礎上：

・要吸引大批科技人員走出試驗室，進入農村廣闊大地，使研究成果和生產實踐更好的結合；

・要把優良品種、科學施肥、栽培技術、節水技術、植保技術、改良土壤等多種措施綜合應用在實驗點上，解決技術的成龍配套和單打一問題；

・要以點帶面，加快科研成果的大面積推廣應用，逐步形成農民自願采用新技術的良好風氣，加快實驗區農、林、牧協調、穩定的發展。

China's agricultural production are that production standards are low and two thirds of the limited cultivable land is of low or medium yield. To overcome these problems, the programme will mainly consider two aspects:

—— To breed improved varieties of major crops and to establish or strengthen the system covering a whole series of services from breeding research to the transfer of breeding techniques for improved varieties;

—— To greatly increase the output of low- or medium-yield land areas through comprehensive measures.

To select and promote the use of improved varieties is an important way to increase yield, featuring low investment for fast return and high benefit. One objective of the programme for the Eighth Five-year Plan is to select and breed 200 commercially improved varieties whose yields would be 8 to 10 percent higher than those of normal varieties. Techniques such as hybridization should be used for research on rice, wheat, millet, cotton, rape, and vegetables.

Low- and medium-yield land has the greatest potential for yield increase, so relevant research work at pilot spots will be heightened. On the basis of the experience and lessons obtained during the Sixth and Seventh Five- year Plans, three measures will be adopted:

—— Attracting more scientific and technical personnel to agricultural production so as to better apply research results to production;

—— Comprehensively adopting such measures as utilization of improved varieties, scientific fertilization, cultivation techniques, water conservation, plant protection, and soil improvement at pilot spots so as to form a complete set of techniques for solving different specific problems;

—— Speeding application of the research results in more and more areas, gradually convincing farmers to adopt new techniques so as to advance the coordinated and stable development of agriculture, forestry and livestock in the pilot areas.

2. 加快傳統工業技術的更新換代和裝備現代化。要繼續加强重大引進技術及裝備的消化、吸收和國產化工作，在完成“七五”結轉項目的同時新開沙漠石油鑽采等一批重點項目。“八五”科技攻關的目標：

①根據生產建設的實際需要，向大型化、實用化、批量化配套發展，爭取在若干領域的生產技術能夠接近和趕上八十年代中后期國際水平；

②以節能降耗爲主要内容爲傳統產業提供一批新技術、新裝備，逐步改變我國工業生產能耗高、效率低的面貌；

③抓好石油、天然氣資源的勘探開發以及煤和有色金屬的綜合利用；

④針對國内外市場需要，開發一批出口創匯新產品，帶動輕紡、精細化工和資源深度加工等技術的發展，爲產品不斷更新換代提供技術儲備。

3. 發展高科技，促進產業化。微電子、計算機、新材料、生物技術是發展高科技的基礎，“八五”科技攻關，堅持基礎和應用并重的方針，安排上技術層次與“863”計劃和火炬計劃相銜接，力爭在“八五”期間有大的突破。

微電子的攻關重點是掌握1－2微米集成電路生產技術；特別是專用集成電路要力爭有一個較好的發展；開展亞微米集成電路技術的研究。

2. To speed replacement of traditional industrial techniques and equipment with modern ones and strengthen the work associated with the adaptation and localization of major imported techniques and equipment. While completing the projects of the Seventh Five-Year Plan, a batch of new projects, such as desert drilling, will be started. The objectives of the programme in this regard will be:

① To have the production techniques of several sectors reach international standards of the middle or late 1980s through acquiring large, practical and batch processing equipment that meets the needs of production construction;

② To reduce energy consumption by providing new techniques and equipment to traditional industry that reverses the situation of high energy consumption and low efficiency in China's industrial production;

③ To strengthen the exploitation of oil and natural gas resources and the comprehensive use of coal and non-ferrous metals;

④ To develop a series of new products for export that meet the demands of domestic and international markets, so as to promote the development of light, textile, and fine-chemical industries and thorough processing techniques for various resources and provide the industries with technological backup for further development of new products to replace old ones.

3. To develop high technology and promote its industrialization. With microelectronics, computer, new materials and biotechnology as the basis for the development of high-tech, the programme will try to advance in both basic research and application, with its technical level associated with that of the 863 programme and Torch programme.

The key tasks in the microelectronic field are to master the manufacturing techniques for 1-2 μm integrated circuits, with special emphasis on the development of special purpose integrated circuits, and to study submicron integrated circuit technology.

The key tasks in the computer field are to develop high-standard microcomputers and work

計算機要重點解決高檔微機和工作站、32位超級小型機及相應的外閑設備。

新材料要滿足新一代尖端技術發展，以及核電、航空航天、高速鐵路、衛星通信等技術發展的需要。研制防核輻射、防生化污染等新材料；研制高性能復合材料、隱身材料；研制結構陶瓷、功能陶瓷材料及制品；研制功能高分子材料及制品。

生物技術攻關要集中力量突出重點，優先解決一批國内急需、技術成熟、經濟效益或社會效益顯著，國内有一定基礎和條件的生物技術新產品。如酶制劑和生化試劑、單克隆抗體、基因工程疫苗、活性多肽、氨基酸系列產品以及利用動植物細胞大規模培養技術生產的次生代謝產物。

4. 改善國民經濟發展的社會環境，推動經濟和社會的協調發展。"八五"社會發展科技攻關重點抓好三方面的工作：

①醫療衛生。要繼續深入開展流行病學、病因學、發病機理及防治措施的研究，爲預防、診斷、治療惡性腫瘤、心腦血管疾病、病毒性肝炎和一些嚴重的傳染病、職業病、地方病提供科學依據和新的技術措施。

②資源的勘測技術。"八五"科技攻關重點是新疆有色金屬礦產資源和揚子地臺西緣有色金屬礦產資源勘測的技術研究。把新疆北部作爲重點，主攻金，兼顧銅、鎳等有色金屬。揚子地臺西緣有色金屬資源儲量豐富，發現了很大的銅礦和鉛鋅礦，已確定的銅儲量爲380萬

stations, 32-bit super minicomputers and associated peripheral equipment.

In the new-material field the main efforts are made to meet the reguirement of developing frontiers technologies, nuclear power station, aeronautic and space technology, high- speed railways, satellite communication, new materials for radioactive- proof and anti- biochemical pollution purposes, high- standard composite materials, concealed materials, structural and functional ceramic materials and products, and functional high-polymer materials and products.

In the field of biotechnology, depending on local conditions, resources will be concentrated to develop, with advanced technology, badly needed new bio- products that may bring high social and economic benefits, such as enzyme preparation, biochemical reagents, McAb, genetic engineering vaccine, active multi- peptide, and amino acid product series, as well as secondary metabolite produced with the technology of large- scale cultivation of animal and plant cells.

4. To improve the social environment for development of the national economy and promote the coordinated development of the economy and society. In the field of social development the programme will focus its work during the Eighth Five-year Plan on three major aspects:

① Medical and health work. The study of epidemiology, pathogeny, and disease mechanism and prevention will be strengthened, so as to provide a scientific basis and technical measures for the prevention, diagnosis and treatment of malignant tumors, cardiovascular and cerebral diseases, virus hepatitis and other serious infectious, occupational and endemic diseases.

② Resource exploration technology. The major work in this field during the Eighth Five-year Plan is to study exploration technology for the non-ferrous metal resources in Xinjiang and the western edge of Yangziditai. Northern Xinjiang will be the major area for the work and gold will be the major resource to be explored; other non-ferrous metals, such as copper and nickel, will also be explored. The western edge of Yangziditai is very rich in non- ferrous metal resources. Very large copper and lead/ zinc deposits have been discovered. The proven copper reserve is 3. 8

噸，后續潛力還相當大，并且該地區在四川與雲南交界處，成礦帶沿成昆鐵路綫分布，開采條件較好。

③生態環境保護技術。“八五”科技攻關重點是開展污水淨化和資源化技術研究，提出城市飲用水源地污染防治和飲用水污染物處理的成套技術；結合工程開發有毒有害廢弃物和城市垃圾處理技術及裝備的研究，變廢爲寶；選擇幾個生態環境脆弱和嚴重退化地區進行綜合整治和恢復技術研究，提出3—4個可供推廣的示範工程技術；選擇酸沉降污染典型地區，研究酸沉降傳輸、影響及其控制技術；開展全球氣候變化規模和預測模式研究，建立與我國相關的全球和區域氣候變化模型。

5. 抓一批對國民經濟發展具有重大影響，帶有方向性、基礎性的長遠項目。科技攻關計劃要繼續貫徹“以任務帶學科”的指導思想，精心選題，要切中要害，突出要點，不求面面俱到。抓一批跨行業、跨學科，對提高生產、工藝、技術水平關系大的牽頭技術。如高速并行處理計算機技術、大屏幕電視平板顯示系統、新一代化工分離技術、AC—600改進型壓水堆關鍵技術、電動汽車技術、磁浮列車及高速鐵路技術等。

“八五”科技攻關計劃安排農業、資源勘探、重大裝備、能源、交通、原材料、機械電子、新興技術、輕紡、醫藥衛生和環境等九個領域170多個項目，在組織管理上有以下新的特點：

①計劃體系的充實和完善。“六五”、“七五”科技攻關計劃是只有國家級的單層次結構，

million tons and has great potential. The location is on the border of Sichuan and Yunnan provinces and the mineralizing belt is distributed along the railway from Chengdu to Kunming, which is good mining condition.

③ Environmental protection technology. The key tasks of the programme in this field are to study waste- water purification and re- use technology, techniques that preventing pollution of and refreshing urban drinking- water sources, processing engineering toxic and harmful wastes and urban garbage, rehabilitating selected areas weak ecologically and seriously degenerated, so as to develop three or four demonstration engineering techniques that can be spread all over, study the transmission and influence of acid rain and the techniques for controlling it at selected areas with typical acid rain pollution, and study the scale of and prediction model for global climate change, so as to set up a model for global and regional climate change related to China.

5. To implement basic long-term projects that will serve as guides and have great impact on development of the national economy. The guiding principle for the programme is "task oriented" so that projects should be carefully selected to emphasize key problems. Special attention should be paid to multi-sector, multi-discipline techniques that critical to increase the level of production, processing and technology such as high- speed parallel processing computer technology, flat display system for large- screen television, new-generation separation technology for the chemical industry, Model AC- 600 improved reactor, electrical vehicle technology, magnetic suspension train and high-speed railway technology, etc.

During the Eighth Five- Year Plan the programme will organize over 170 projects in the fields of agriculture, resource exploration, major equipment, energy, transportation, raw materials, machinery and electronics, new technology, light and textile industries, medical and health work and the environment. Administration of the programme has the following features:

①Complementing and improving the planning

"八五"科技攻關將形成一個多層次立體結構的全國性計劃，由國家、行業、地區三個部分組成全國科技攻關計劃。不同層次的攻關計劃解決不同層次的問題。國家科技攻關計劃將是全國科技攻關計劃的重點，集中力量解決帶有全局性的跨地區、跨行業的重大問題。項目少而精，要集中全國的科技優勢力量，集中國家的物力和財力，突破這些全局性的重大科技問題。行業科技攻關計劃應當突出行業重點，選擇那些對推動行業發展起關鍵作用的重要科技問題，加以突破。地方要有計劃地逐步建立各具特色的攻關計劃，根據本地區的資源特點，經濟發展狀況等實際情況，集中力量解決對振興地方經濟起關鍵作用的重要科技問題。

② "八五" 科技攻關計劃的執行要適應經濟體制改革和科技體制改革的總趨勢，引入競爭機制：

· 推動滾動式計劃體制，改變計劃確定后應變能力很差的局面。要根據情況的變化，同時，因事地進行計劃的調整、補充、修改。

· 推行公開招標，提高透明度。"八五" 科技攻關項目將盡力創造條件，面向全社會公開招標，促進平等競爭，充分調動高校系統、中國科學院、各產業部門、軍工系統、企業集團和各省、市地方所屬研究系統等方面的積極性，以利于真正做到集中優勢力量。

· 堅持經費匯有償使用和撥款相結合的原則。并加强科研項目經費的管理，實行預決算制。

③統一計劃，多方集資。幾年來，我國經濟體制改革不斷深化，兩級財政體系和包干制度已經建立，并不斷趨于完善。而對這種形勢，

system. Instead of a single, national level, as in the Sixth and Seventh Five-year Plans, the programme in the Eighth Five-year Plan has a multilevel structure of national, sectorial and regional programmes. The programme at different levels will solve different problems. The national-level programme will be the key programme, concentrating resources to solve key transregional and trans-sectorial problems. A limited number of projects have been carefully selected. The sectorial programme will concentrate on the sector and solve key technical problems of critical significance in promoting sectorial development. Regions will gradually establish a special problem-solving programme to suit local resources and economic development, so as to concentrate resources to solve key technical problems of great importance to local economic development.

② Introducing competitive mechanisms into the programme and adapting the general system of economic, scientific and technological reform, including:

—— Flexible planning to overcome the problems of a fixed plan. The flexible plan may be adjusted, supplemented or revised according to the changing situation.

—— A public bidding system to open the programme wider to the public. The programme will whenever possible use a public bidding system for its projects in order to fully mobilize, through equal competition, the enthusiasm of the higher-education system, the Chinese Academy of Sciences, various industrial sectors, the war industry system, enterprise groups and research institutes of provinces and cities. This will facilitate the concentration of resources for the programme.

—— The use of both grants and loans for funding projects. The management of project funds will be strengthened and a budget and account system will be adopted.

③Making a centralized plan and raising funds from different sources. In recent years economic reform in China has deepened and a dual-level financing system and individual-responsibility system have been set up. Thus it is natural for the

各層次的科技攻關項目所需經費，依靠多方集資，把各方面的分散資金引導到依靠科技進步提高經濟效益上來，已經成爲科技攻關計劃在經費方面的必由之路。"八五"科技攻關計劃的安排不僅在計劃內部要注意國家、行業、地方各部分之間的系統性和一致性。同時，一定要注意與財政、銀行等金融系統支持的各項計劃相配套，真正發揮科技推動經濟發展的作用。

programme to rely on different sources for funding projects at different levels and to attract different funding sources to use their funds to increase economic benefits through science and technology. Not only should internal relationships between national, sectorial, and local levels of the programme be systematic and consistent, but the programme's relationship to other programs supported by banks and other financing systems should be heeded, so as to highlight the significance of science and technology in promoting economic development.

高技術研究發展（八六三）計劃

THE HI-TECH RESEARCH AND DEVELOPMENT (863) PROGRAMME

計劃的歷史背景

Historical Background

八十年代以來，世界新技術革命的顯著特點是在高技術和高技術産業之間的競爭，已完全超出私人産業集團之間的競爭範圍。成爲國與國之間，集團與集團之間軍事、政治、經濟競爭的“制高點”。世界各國普遍認識到，發展高技術與高技術産業是增强綜合國力的重要砝碼，是關系到國家興衰存亡的大事。因此，無論是發達國家，還是發展中國家，都爲發展自己國家的高技術和高技術産業制定了相應的發展戰略，并不斷推出了各種中、長期的高技術研究與發展計劃。繼美國 SDI 戰略防御倡議計劃之后，歐洲“尤里卡計劃”、日本的“科學技術立國”等高技術發展戰略計劃相繼亮相。一些着眼于 21 世紀的新技術開發計劃，如歐洲經濟共同體的“信息技術研究發展戰略計劃(ESPIRT)、“尖端通信科研合作計劃”，日本的“第五代計算機研究開發計劃”和“人體新領域研究計劃”等應運而生。與此同時，一些新興工業化國家和地區紛紛制定了新的發展計劃和提出各自相應的對策，以求在這場波及全世界的高技術競爭中尋求新的發展機遇。

黨和國家領導人十分關心我國高技術的發展。1986 年 3 月，肯定了由王大珩等四位著名

Since the 1980′s, a distinguished characteristic of the worldwide new technology revolution is that the competition in the field of hi-tech and hi-tech industries is completely beyond the scope of competition among the private industrial groups and becomes the "commanding elevation" of military, politics and economy among the countries and groups. Every country has realized thatthe development of hi- tech and hi- tech industry is a major measure for the enhancement of the comprehensive capability of the country and is critical to the country′s future. Either developed or developing countries have set up their strategies for the development of hi- tech and hi- tech industry, and worked out one after another medium- and long-term hi-tech R&D plans such as the Strategic Defense Initiative of the United States, EURICA of Europe, Foundation of the State with Science and Technology of Japan, ESPRIT and RACE of EEC, the Fifth Generation Computer and the Research Programme on the New Areas Related to Human Body of Japan. In the meantime, some newly developed industrialized countries and regions have made new development plans and appropriate measures in order to find new development opportunities in the hi- tech competition affecting the whole world.

The leaders of the Chinese government are much concerned about our hi-tech development. In March 1986, the suggestion for tracing world advanced level and developing our hi-tech made by Mr. Wang Daheng and other three outstanding scientists was considered as acceptable and important comments were given by the leaders.

科學家提出的跟踪世界先進水平、發展我國高技術的建議，做了重要批示。之后，經過全國200多位專家的全面論證，提出了我國的“高技術研究發展計劃綱要”(簡稱863計劃)，1986年8月和10月國務院黨務會議和中央政治局擴大會議分別審議批準了這個綱要。

The " Guidelines of Hi- tech Research and Development Programme (863 Programme)" was then proposed on the basis of complete appraisal of the suggestion by over 200 experts all over China and was discussed and approved separately at the Meeting of the Standing Committee of the State Council in August 1986 and the Enlarged Meeting of the Central Political Bureau in October 1986.

計劃的目標和任務

Objectives and Tasks

我國是一個發展中國家，從國情出發，我國在一定時期内，還没有條件投人大量人力、物力、財力，去全面大規模地發展高技術。因此，八六三計劃堅持“有限目標，突出重點”的方針，選取了生物技術、航天技術、信息技術、激光技術、自動化技術、能源技術、新材料等七個領域作爲我國今后高技術發展的重點。通過《綱要》的組織實施，力爭達到：

①積極跟踪，注意創新，瞄準世界高技術發展前沿，縮小同國外先進水平的差距，在某些有一定優勢的項目上有所突破；

②培養和造就一批新一代學科配套、結構合理、有旺盛創造力的高水平科技人才隊伍；

③將開發的階段成果盡快商品化、產業化，爲改造傳統產業服務爲形成新興高技術產業奠定基礎，爲本世紀末下世紀初國民經濟的發展和國家安全服務；

④對全國範圍内的高技術發展起到先行和推動的作用。爲到2000年后我國形成具有相當優勢的高技術產業創造條件，爲國民經濟向更高水平的穩定持續發展準備后勁。

As a developing country, China, taking account its local conditions, is not ready to input a large amount of manpower, material and fund to develop hi-tech in full scale in the near future. The policy of "Limiting objectives and concentrating on key areas" is firmly adopted in 863 Progamme and seven major areas of our future hi- tech development are selected. Namely, biotechnology, space technology, information technology, laser technology, automation technology, energy technology, and new materials. The objectives for the implementation of the Guidelines will be:

① To monitor the latest international hi-tech development, pursue innovation, narrow gaps between Chinese and foreign technologies, strive for breakthroughs in areas where China is strong.

② To train and cultivate a new generation of high level S&T work force of complete disciplines which should be creative and well structured.

③ To commercialize and industrialize the phasic achievements so as to serve the reconstruction of traditional industries, lay a foundation for the formation of new hi- tech industry and, the economic development and state security for the years around 2000.

④ To play a leading and promotional role for the nationwide hi- tech development, create opportunities for China to form its highly advantageous hi- tech industry after year 2000, and prepare back- up support for the stable and continuous upgrade of national economy.

計劃的主要內容

Contents

中國高技術研究發展計劃(八六三計劃)選擇生物技術、航天技術、信息技術、激光技術、自動化技術、能源技術和新材料七個領域爲發展高技術的重點。

——**生物技術**發展的目標是到下世紀初更好地滿足人民營養需求和提高健康保障水平。它的研究內容爲：

1. 高產、優質、抗逆的動植物新品種——定向創造動植物新品種，以求提高糧食和肉、魚、奶產量。到本世紀末，創造出雙季平均每公頃產量超過 15 噸的亞種間雜交稻新組合；培育蛋白質含量高的小麥新品種；抗病、抗蟲、高蛋白的蔬菜新品種；耐旱、耐鹽碱、高蛋白的牧草新品種；提高玉米、大豆和蔬菜作物的共生與聯合固氮能力，減少化肥用量；培育抗病、抗寒新魚種；掌握使奶牛繁殖率提高的技術。

2. 新型藥物、疫苗和基因治療——研究開發新型藥物和疫苗，防治發病率高、危害大、近期尚無有效手段控制的惡性疾病。研制出可以有效防治某些癌症、心血管病和人、畜主要傳染病的新型藥物和生物制品。開發生物反應工程、產品分離、純化工程，并有效地轉化爲生產力。研究某些遺傳病和腫瘤的基因診斷和治療。

3. 蛋白質工程——開發新一代遺傳工程的蛋白質工程技術，爲醫藥、化工、食品和農業生產開辟新途徑。

——**航天技術**研究發展性能先進的大型運載火箭，提高我國航天發射商業服務能力，繼

China' s Hi-tech Research and Development (863) Programme has seven priority development areas — biotechnology, space technology, information technology, laser technology, automation technology, energy technology and new materials.

—— **Biotechnology** objectives are to meet nutrition needs and increase health levels by the beginning of the next century. Research subjects are:

1. High-yield, high-quality and adverse-prce varieties of animals and plants to increase grain, meat, fish and milk yields. By the end of this century to create a new hybrid double-harvest rice with a yield of over 15 tons per hectare, to cultivate new varieties of high-protein wheat, disese- and pest-resistant high-protein vegetables, and drought proof, saline/alkali-resistant high-protein pasture, to increase the capability of corn, beans and vegetables for symbiosis and joint azofication, so as to decrease the amount of fertilizer to be used, to create new varieties of disease- and cold-resistant fish, and to master the techniques for increasing the birth rate of dairy cattle.

2. New medicine, vaccines and genetic cures — to study and develop new medicines and vaccines for preventing serious diseases that currently cannot be effectively controlled, to develop new medicines and bio-products that can effectively combat certain cancers, cardio vascular disease and major infectious diseases in humans and animals, to develop the techniques for bioreactive engineering, product separation and purification engineering and transform them into production forces, and to study the genetic diagnosis and treatment of some hereditary diseases and cancer.

3. Protein engineering — to develop protein-engineering techniques of new generation genetic engineering, so as to break a new path for medical, chemical, food and agricultural industries.

—— **In space technology** the work will be to develop large advanced carrier rockets, so as to strengthen commercial launching services, and to

續進行爲和平目的的空間科技的研究與開發。

——**信息技術**的目標集中在下世紀初可能有重大突破，并具有廣泛應用前景的技術上。

1. 智能計算機系統——研制具有智能體系結構、知識處理和智能處理能力的智能機和具有自然人機對話方式的接口，發展軟件自動化技術。促進人工智能的應用，爲形成智能計算機產業打下基礎。

2. 光電子器件與微電子、光電子系統集成技術——發展用于傳感、計算、通信等方面的新型光電子器件和系統集成技術，探索制造大規模集成電路的新途徑，爲發展新型信息獲取處理系統、計算機、通信設備打下技術和物質基礎。

3. 信息獲取與處理技術——爲發展新的智能化工業自動化系統的需要，發展多種信息獲取與處理技術，重點是掌握新型信息獲取和實時圖象處理技術，促進信息技術在資源勘察、氣象預報、海洋監測、農林以及工業產品質量控制等各個領域的應用。

——**激光技術**研究高性能和高質量的激光技術，把成果應用于生產；帶動脈冲功率技術、等離子體技術、新材料及激光光譜學等技術科學的發展。

——**自動化技術**

1. 計算機綜合自動化制造系統(CIMS)——針對多品種、小批量、高質量、對市場反應靈活和產品更新換代快等新一代自動化生產技術的需要，跟踪研究計算機綜合自動化制造系統的關鍵技術，建成示範生產綫。

2. 智能機器人——研制出精密裝配作業、水下作業和惡劣環境作業等三種不同類型的智能機器人。

continue research and development of space technology for peaceful purposes.

——**Information technology** work will focus on techniques with great potential for development and wide application in the next century.

1. Intelligent computer system — to develop an intelligent computer system capable of knowledge and information processing, to develop a man- machine interface to develop software automation techniques, to promote the application of artificial intelligence, so as to lay a foundation for the intelligent computer industry.

2. Optoelectronic components and integrating techniques for micro-electronic and optoelectronic systems—— to develop new optoelectronic components and system-integrating techniques used for sensing, computing and communication, to explore new ways for producing large, integrated circuits, so as to be technically and practically prepared for the development of new information acquisition and processing systems, computers and communications equipment.

3. Information acquisition and processing technologies — to develop various information acquisition and processing techniques to meet the needs of new intelligent industrial automation systems. Emphasis should be on new information acquisition techniques and real- time image processing techniques, so as to promote the application of information technology in such areas as resource exploration, weather forecasting, ocean monitoring, agriculture, and quality control for industrial products.

——In **laser technology** we shall study high-standard and high- quality laser technology and apply research results to production, so as to promote the development of pulse- power techniques, plasma technology, new materials, laser spectroscopy, etc.

——**Automation technology**:

1. Computer Integrated Manufacturing System (CIMS) — to track the key technology of CIMS and set up demonstration production lines to meet the need for new-generation techniques for producing various kinds of high-quality, small-quantity, flexible and new products.

2. Intelligent robot — to develop intelligent robots for precision assembling, underwater and unhealthful environment etc..

——能源技術

1. 燃煤磁流體發電技術——研究開發燃煤磁流體發電技術，大幅度提高熱能的轉化效率，節省煤炭資源，燃用我國豐產的中等煤和高硫煤，減少燃煤發電帶來的煤炭運輸和污染問題。

2. 先進核反應堆技術——面向二十一世紀的核能發展，對快中子增殖堆、高溫氣冷堆及以現有核聚變技術成就爲基礎的裂變—聚變混合堆進行實驗研究，以開發能大幅度提高核燃料利用率、安全性與經濟性好的堆型。

——新材料

新材料的主攻方向是：①光電信息材料；②耐腐蝕、重量輕的高性能結構材料；③特種功能材料；④耐高溫、高韌性、高强度的復合材料；⑤開展特種工藝測試與檢驗等方面的研究。探索不同層次微觀結構理論指導下的材料設計、研制及與應用工藝技術相結合的現代材料科學技術指導新材料的發展。

——Energy technology:

1. Coal magnetic fluid power-generation technology — to study and develop coal magnetic fluid power-generation technology, in order to greatly increase the efficiency of transforming heat energy, save coal resources, use the medium grade coal and high-sulfur coal abundant in China, and solve the problems of pollution and transportation associated with coal power generation.

2. Advanced nuclear reactor technology — to prepase for nuclear energy development in the 21st century, to conduct experimental studies on fast neutron breeder reactors, high-temperature air-cooled reactors as well as fission/fusion reactors based on the existing fusion technology, so as to develop safe and economical reactors that will greatly increase the nuclear fuel ratio.

——New materials:

Focuses are: ① optoelectronic information materials; ② high-performance, anti-corrosion and light structural materials; ③ special-function materials; ④ high-temperature, tough, strong composite materials; ⑤ the research on special-process testing and examination and modern material science and technology, combining material design, development and application under various levels of micro-structure theory to guide the development of new materials.

實施計劃的政策和措施

Policies and Measures for Programme Implementation

八六三計劃的實施不僅爲我國高技術的研究發展出成果、出人才提供了條件，同時還爲進一步深化科技體制改革創造了條件。爲保證計劃目標的實現，八六三計劃的管理借鑒了國外高技術管理的經驗并結合我國具體情況，制定了一系列行之有效的政策和措施爲我國科技體制改革和組織管理開辟出一條新路。

1. 集中力量，統一指揮

打破部門、地區的界限，集中優勢力量確

Implementation of the 863 programme will not only facilitate obtaining achievements and talent for R & D work in high technology, but further reform of the science and technology management system. To ensure the programme's objectives are met, a series of policies and measures, combining, foreign experience in hi-tech management and China's local conditions, will guide scientific and technological reform and administration.

1. Concentrate resources under the general leadership. The boundaries between various sectors and regions will be ignored in order to concentrate resources and ensure implementation of the

保計劃的實施，在落實任務和經費分配時實行招標或擇優委托，把任務落實到確有優勢的單位和專家集體，經費隨之下撥，專款專用，在人、財、物上集中力量統一指揮，充分發揮有限資源的作用。

重大問題的決策和協調，由國務院高技術計劃協調指導小組負責。

2. 大力協調，相互銜接

要充分利用我國已有的試驗裝備和工作條件，實行多種形式的聯合，可以把承擔任務的單位組成柔性研究機構或聯合研究開發中心，發揮各自的優勢和潛力。

做好八六三計劃與其它科技計劃中的有關項目的銜接，互爲補充。所取得的階段研究成果，要密切地同其它推廣應用計劃相銜接，迅速地轉化爲生產力，發揮經濟效益。

3. 實行專家決策管理，充分發揮專家在咨詢，評議以及決策管理中的作用。

4. 發揮中青年專家的作用。八六三計劃要連續執行到二十世紀末，要特別重視年輕一代科技人員的培養，注意發現和起用優秀的中青年科技人才，在老科學家的關懷和指導下，由中青年專家挑大梁，領導和指揮研究工作。

5. 項目的實施强調跟踪前沿、目標驅動的方針，凡是能拿到目標產品的項目，要努力爭取實現。

6. 積極開展國際合作，通過政府間的多邊關系，雙邊關系和各種民間渠道開展國際合作和交流。采用各種方式進行人員交流及學術交流，在國際高技術研究開發環境中，培養和造就一批高水平的科技人才。積極聘請外國專家來華進行學術交流、講學和合作研究。

programme. The implementing units for the projects will be designated on the basis of bidding or competition and funds will be granted after the project has been assigned to a unit or a group of experts. Funds can be used only for the specified work. In this way the limited resources of personnel, funds and materials can be pooled to play a greater role under the unified leadership.

2. Play a coordinating role. Testing equipment and facilities in China should be used fully through various forms of cooperation. For example, a flexible research unit or joint R & D center can be formed by the different implementing units of the programme, each contributing its advantages and potential.

Projects of the 863 Programme should be well connected with those of other S & T programs. For example, the intermediate results of a project under the programme should be transferred rapidly to industry and create economic benefits through other dissemination and application programs.

3. Adopt an expert decision- making and management system to allow experts to play an important role in consulting, decision making and management. Experts will be given the right, responsibility and duty to plan the project. organize the work, and decide how to allocate funds.

4. Use middle-aged and young experts. The programme will not be completed until the end of the 20th century, so special emphasis should be placed on training a new generation of scientific and technical personnel. Some of the best middle-aged and young S & T personnel should be selected to lead and guide the research work under the careful guidance of older scientists.

5. Tracking frontiers and pursuing objectives are the policies for implementating the programme. All the projects with product aims will be implemented.

6. Develop international cooperation through bilateralA, multilateral, governmental and non-governmental channels. Various ways for expert exchange and academic links will be adopted to train high-level Chinese S & T personnel in an international hi- tech R & D environment and invite foreign experts to give lectures and do joint research in China.

計劃實施進展

Progress of the Programme Implementation

八六三計劃的實施，使我國最重要的七個高技術領域的研究進人到一個以國家規模有計劃、有組織地發展的新階段。這對中華民族的振興、科技水平的提高及國家實力的增强都具有重要而長遠的影響。八六三計劃經過項目論證和課題分解，1988 年進人全面實施。五年來，八六三計劃起步良好，人軌較快，取得了可喜進展。提高了我國高技術研究水平。增强了我國的實力，縮小了同國外的差距，開拓了具有中國特色的研究領域。主要表現爲：

形成了我國高技術研究發展的總體布局；組織了一支陣容整齊的精干的國家高技術研究隊伍。國家科委負責組織實施的生物技術、信息技術、能源技術、新材料五個領域，共聘任了 132 位專家組成領域專家委員會、主題專家組。參加研究工作的科技人員已達一萬人以上；組建了八個研究開發中心（計算機綜合自動化制造系統的實驗工程研究中心、智能計算機系統研究開發中心、智能機器人研究開發中心、光電子工藝中心、基因工程疫苗中心、基因工程藥物中心、基因工程生物制品中心、人工晶體聯合研究開發中心），形成了我國高技術研究和攻關的人才培養、單元技術實驗及集成、開發目標産品的基地和對外交流與合作的窗口；建立了科學決策、專家負責、分層管理的運行機制；取得了一大批高技術科研成果。

“七五”期間，僅在生物技術、信息技術、自動化技術、能源技術和新材料五個領域取得成果 400 多項，其中達到國際八十年代中、后期水平的成果 52 項，在我國高技術發展中起

Through the implementation of 863 Programme, the research work in the seven most important hi-tech areas in China has been upgraded into a new phase of nation-wide planned and organized development, which has important and long influence on vigorously developing the Chinese nationalities, increasing S&T level and enhancing national capabilities. The Programme have been fully carried out since 1988 on the basis of project appraisal and topics division. The Programme had a very good beginning and came onto the right track soon after beginning, so that it has got such an exciting progress in the 5 years that our hi-tech research level is increased, national capability enhanced, gap to foreign level closed, and research areas of Chinese characteristics developed. The major areas of the progress are as follows:

The overall layout for China' s hi-tech research and development is formed up, and a well-balanced and capable national hi-tech research team is organized. 132 experts and more than 10000 S&T workers are engaged in the five areas of biotechnology, information technology, automation technology, energy technology, and new materials. Eight research and development centers are established, namely, CIMS Experimental Engineering and Research Center, Intelligent Computer System R&D Center, Intelligent Robot R&D Center, Optoelectronic Processing Center, Genetic Vaccine Center, Genetic Medicine Center, Genetic Bio-products Center, and Joint R&D Center for Artificial Crystal. A base is established for the training of our hi-tech research personnel, the experiment of unit technology and the development of target product. The channel for foreign exchange and cooperation is set up. An expert charged operation system is established which involves scientific decision making and management in different levels. And a large amount of hi-tech research achievements are obtained.

During the period of the Seventh Five-Year Plan, more than 400 fruits were got in the five areas, among which 54 items reached the world level of the middle and late 80' s. They played a

了帶頭和核心的作用，爲國民經濟的發展和社會進步作出了直接的貢獻。

leading and core role in our hi-tech development and made direct contribution to the development of national economy and the society advancement.

"八五" 工作重點

Key Tasks in the Eighth Five-Year Plan

"八五" 期間，八六三計劃生物技術、信息技術、自動化技術、能源技術和新材料五個領域工作總的要求是：積極跟踪國際高技術的發展，集中力量進行關鍵技術的攻堅，力爭取得重大突破，與此同時，要認真抓好一批高技術研究中心和重大試驗項目的建設，培養一批高水平的科技人才，加速一批階段成果的推廣，從而開創我國高技術研究、應用和開發的新局面。

我們相信：通過十年的計劃實施，到本世紀末，我國高技術研究水平水平必將會大大提高；有一批關鍵技術將達到國際前沿水平，有相當一批研究成果轉化爲商品，投放市場，直接爲國民經濟翻兩番做出貢獻；先進的高技術研究開發基地和一支素質良好的研究隊伍將爲下世紀開展更高層次的研究，打下一個好的基礎。

During the period of the Eighth Five-Year Plan, the general requirement of 863 Programme for the five areas of biotechnology, information technology, automation technology, energy technology, and new materials are: to monitor the latest international hi-tech development, to concentrate resources on problem-tackling for key technologies, to try for key breakthroughs, in the meantime, to pay attention to the establishment of a number of hi-tech research center and key laboratories, to train a batch of high level S&T personnel, to speed up the popularization of phasic results, and to bring our hi-tech research, application and development into a new era.

We believe that until the end of this century when the Programme is implemented for 10 years, the hi-tech research level of China must be greatly upgraded, a number of key technologies will reach the world most advanced level, and a large number of research achievements will be transformed to commodities to be marketed which will serve the objectives of the government to increase national production value by three times. The advanced hi-tech R&D base and high quality research team will lay a solid foundation for the higher level research of the next century.

國家基礎性研究重大項目計劃
NATIONAL BASIC RESEARCH PRIORITIES PROGRAMME

計劃的目標
•Objectives

"八五"期間國家基礎性研究重大項目計劃（攀登計劃）是以指導性和指令性相結合的計劃，該計劃的目標是：加强人才培養，大力提高研究人員的素質和水平；增强我國學術界在主要基礎學科領域和新興學科、交叉學科領域的學術地位，在主要的學科領域跟上世界發展的步伐，在一些基礎較好的學科領域有所創新、有所建樹；不斷增强解決我國國民經濟和社會發展中重大問題的能力，在農業、能源、材料、信息以及人口、醫學、資源、環境、生態、重大自然災害等方面開展多學科的綜合研究，爲重大問題的解決提供理論依據和技術基礎。基礎性研究計劃優先支持的原則是：對國民經濟、社會發展有重大和廣泛應用前景的、當代活躍的學科前沿項目；能充分發揮我國智力資源、自然資源優勢或地理特色的項目；已有較好基礎，接近或達到國際先進水平的項目。

During the Eighth Five- year Plan, the National Basic Research Priorities Programme (the Climbing Programme) is a combination of guidance and mandatory. Objectives are to foster qualified personnel and improve the quality and ability of research workers; to consolidate the academic position of the science community in major areas of basic research and emerging branches of science and technology, keeping abreast of global developments in major fields of research and progressing to in fields with solid foundtion; to continually strengthen the ability of the nation to handle significant problems in economic and social development by implementing comprehensive studies in the fields of agriculture, energy, raw materials, and information as well as population, medical science, resources, environment, biology, and large natural disasters and through providing theoretical and technical bases. The order of preference in the Basic Research Programme is: frontiers of research leading to significant and wide application in economic and social development; fields fully utilizing the nation' s intellectual and natural resources and geological characteristics; and subjects either enjoying solid foundation or approaching or reaching world advanced standards.

計劃内容：
Contents

1. 以認識自然現象、揭示客觀規律爲主要目的的研究；

1. Research on knowledge of natural phenomena and objective laws;

2. 圍繞生產實踐和學科發展提出的具有重大或廣泛應用目標、探索新原理、開辟新領域的定向性研究；

3. 對基本的科學數據進行系統的考察、采集、鑒定，并進行綜合、分析、探索基本規律的工作。

2. Selected research leading to wide application or the finding of new laws and the opening of new fields, emerging from practice or as a result of the development of subjects;

3. Investigation, collection and identification of basic data, their comprehension and analysis, and, above all, search for basic laws.

計劃實施的政策與措施
Policies and Strategies

- 逐步增加對基礎性研究的投人；
- 對基礎性研究實行多渠道、多種形式的支持；
- 基礎性研究隊伍要精干，素質要提高，鼓勵科學家在國際前沿領域開展研究；
- 支持開放實驗室的運行，有重點地改善物質條件，創造良好的學術環境；
- 積極推動國際合作與交流。

- Gradually increase the input in basic research;
- Support basic research through diversification;
- Train research forces, improve their quality and encourage them to work in world fronts;
- Support open laboratories, improve working conditions, and generate a better academic environment;
- Promote international cooperation and exchange.

計劃實施的方法與步驟
Procedures for Execution

研究項目分爲自選課題、重點課題和重大項目三種類型。基礎研究重大項目屬指令性計劃，由國家規劃和組織實施；重點課題屬指導性計劃，由國家統一規劃，各部門根據學科發展和本部門實際需要組織實施；自選課題是由科學家個人或集體根據對世界科學發展的判斷、自己的特長和意向提出的，由科學基金和部門事業費支持。

Research projects are classified into three types: self- selected, key and significant. Significant projects are under the guidance plan and their execution is supervised and organized by the state, while key projects are under the mandatory plan drafted by the state and their execution is supervised accordingly by each sector in line with the development of the subject and the actual necessity of the sector; self-selected projects are proposed by individual or groups of scientists according to world developments in science and technology, the scientists specialties and their opinions, supported by the Science Fund and sector operating expense so.

"八·五"計劃要點和任務

Trends and Tasks in the Eighth Five-year Plan Period

"八五"期間國家支持科學家自選的基礎性研究課題2萬項。選擇了7個基礎學科：數學、物理學、化學、力學、天文學、地理學、生物學；8個應用基礎學科：能源科學、材料科學、信息和計算機科學、基礎農學、基礎醫學、資源和環境科學、空間科學、工程科學；并從上述15個學科中選出79個優先領域，給予重點支持和發展。國家將組織有關科學家論證確立和實施約30項基礎性研究重大項目。

在"八五"期間，國家對基礎研究的投人將有所增加，從占整個科技撥款的7%提高到8—9%。同時，國家還將加强重點開放實驗室的建設，努力解決儀器設備更新和運行補助費。

During the Eighth Five-Year Plan period the state will support 20000 self-selected projects. Seven branches of basic research have been selected, including mathematics, physics, chemistry, mechanics, astronomy, geography, and biology. Eight branches of applied research include energy, materials, information and computer science, basic agronomy, basic medical sciences, resorce and environment science, space science and engineering science. Seventy-nine fields in 15 scientific areas will receive special support under the supervision of their own sectors. About 30 significant basic research projects have been identified through the recommendation of scientists.

During the period the state's input in to basic research will be increased slightly, from the current 7 percent to 8 or 9 percent of the total allocation for science and technology. Meanwhile, the state will strengthen the construction of key national laboratories open to the public, especially in the renewal of laboratory instruments and operational subsidies.

國際合作前景

Prospects for International Cooperation

國家科委推動基礎性研究的國際合作是通過多渠道進行的，包括在政府間的科技協議中强調基礎性研究合作的內容；申請聯合國教科文組織等國際組織的資助項目；通過科委交流中心支持各部委的國際合作和促進民間交流合作等。例如，我們正在區域合作和外空合作等方面爭取聯合國組織和其它國際組織的資助，還通過許多官方和半官方科技負責人的接觸和洽談，推進基礎性研究的國際合作與交流。

In promoting international cooperation in basic research, the State Science and Technoiogy Commission has adopted a policy of diversification, including emphasizing the importance of basic research in inter-governmental agreements, applying for aid from UN organizations and promoting government and non-governmental cooperation and exchange through the Exchange Center of the State Science and Technology Commission, inter-regional cooperation, outer space cooperation, contacts between officials or semi-officials who in charge of science and technology.

火 炬 計 劃
TORCH PROGRAMME

計劃的性質與宗旨
Nature and Purpose

火炬計劃是一項指導性的高新技術產業開發計劃，于 1988 年 8 月經國務院批準，由國家科委組織實施。火炬計劃的宗旨是，貫徹執行改革開放的總方針，發揮我國科技力量的優勢，促進高新技術成果商品化、高新技術商品產業化和高新技術產業國際化。

The Torch Programme is a guideline programme for developing new/ high technology industries. In August 1988 the State Council approved the programme and put the State Science and Technology Commission in charge of organizing and implementing. The purpose of the programme is to carry out the general policy of reform and opening to the outside world, bring into full play the advantages of China' s scientific and technological forces, and promote the commercialization, industrialization and internationalization of new/high technologies.

計劃的主要發展目標
Main Development Goals

1. 組織好火炬計劃項目，加快我國高新技術成果商品化、產業化、國際化的步伐，加速用高新技術改造傳統產業的進程，推動我國產業結構的合理調整，以大幅度提高勞動生產率，力爭在 20 世紀末形成具有相當規模的高新技術產業群體，使高新技術產業的總產值在我國國民經濟總產值中占有不可忽視的份額，并使高新技術產品的出口額占其總產值的 30%左右。

2. 辦好高新技術產業開發區，使之成爲發展我國高新技術產業的主要基地，力爭在 20

1. Organize Torch Programme projects well; speed the commercialization, industrialization and internationalization of China' s new/ high- tech products; speed renovation of traditional industries by new/ high technologies; promote the rational readjustment of China' s industrial structure to significantly raise productivity; strive to form new/high-tech industrial groups of considerable size by the end of the twentieth century, so that the output value of new/high-tech industries will constitute a significant part of our GNP and the export volume of new/high-tech products will be about 30 percent of the total output value of such products.

2. Run the new/ high- tech industrial development zones well so that they will become the main bases for developing China' s new/high-tech industries and strive to reach by the end of the

世紀末使高新技術産業開發區内的高新技術産品的總産值占全國高新技術産品總産值的50%以上。

3. 建立一大批以國内外市場爲導向、運行機制靈活、開發能力强、經濟效益高的技工貿一體化的高新技術企業，重點支持和發展一批在國内外市場具有競爭能力的高新技術企業集團，使之成爲高新技術産品出口和對外開放的骨干。

4. 培養和造就一大批了解國内外市場，懂技術開發和商品生産、會管理、善經營，掌握國際貿易知識的科技企業家和高級經營管理人才。

twentieth century the goal whereby the total output value of new/ high- tech products in the development zones constitutes over 50 percent of the total output value of new/high-tech products in the nation as a whole.

3. Establish numerous new/ high- tech industries that are oriented toward both domestic and overseas markets, flexible in operation, strong in development, and high in economic performance, and that combine R&D, production and trade in an integrated complex; give priority to supporting the development of new/and high-tech enterprise groups that are competitive in both domestic and overseas markets, so that they will become the mainstay enterprises in exporting new/high-tech products and in implementing the policy of opening to the outside world.

4. Train and foster contingents of scientists, engineer-entrepreneurs and senior managers who have a good knowledge of domestic and overseas markets, international trade, research and development, and commodity production and are good at management and operation.

計劃的主要内容

Main Contents

1. 創造適合高新技術産業發展的環境和條件

制訂中長期發展規劃；制訂有利于高新技術産業發展的政策和法規；組織和實施綜合性的改革，建立適應高新技術産業發展的管理體制和運行機制；開辟資金渠道，建立風險投資機制；開辟國内外信息渠道，建立信息網絡；廣泛開展宣傳工作，動員社會各界支持和參與火炬計劃的實施。

2. 辦好高新技術産業開發區

高新技術産業開發區是火炬計劃的重要

1. Creating proper conditions and environment for the development of new/ high technologies, including:

Planning medium- and long- term development; Formulating policies and regulations conducive to the development of new/high-tech industries; Organizing and implementing comprehensive reforms and establishing management systems and operating mechanisms suited to the development of new/ high technologies; Opening up funding sources and building up risk investment mechanisms; Opening up domestic and overseas information channels and establishing information networks; Increasing propaganda efforts and calling on all sectors of society to support and participate in implementation of the Torch Programme.

2. Running the new/ high- tech industrial development zones well

New/high-tech industrial development zones

組成部分。在人才、技術密集或對外開放環境條件較好的大中城市興辦高新技術産業開發區，是促進我國高新技術産業發展的一個重要而有效的途徑。高新技術産業開發區應成爲發展高新技術産業的重要基地、向傳統産業擴散高新技術的輻射源、對外開放的“窗口”、深化改革的試驗區。

目前，經國務院批準的國家高新技術産業開發區共 27 個。這些開發區分布在北京、武漢、南京、沈陽、天津、西安、成都、威海、中山、長春、哈爾濱、長沙、福州、廣州、合肥、重慶、杭州、桂林、鄭州、蘭州、石家莊、濟南、上海、大連、深圳、廈門、海口等城市。

國務院還批準了高新技術産業開發區的優惠政策及區内高新技術企業的認定辦法。

開發區的基本任務是，通過深化改革，制定配套的優惠政策，改善投資環境，籌集資金，建立完善的支撑服務體系，鼓勵和吸引科研院所、高等院校、企業以及廣大科技人員到開發區創業，按照“自願組合，自籌資金，自主經營，自負盈虧，自我約束，自我發展”的機制創辦高新技術企業，開發高新技術産品，發展高新技術産業。

高新技術創業服務中心是火炬計劃和高新技術産業開發區的新型支撑性的服務機構。其基本的工作方式是從項目“孵化”入手，培養高新技術企業及企業帶頭人。“孵化”項目成功之后即可進一步形成一個完整的具有一定規模

are an important component of the Torch Programme. Establishing such zones in big and medium cities that enjoy an abundance of human and technical resources or possess a good environment for opening to the outside world is an important and effective approach in promoting the development of new/high-tech industries in China. These zones will become important bases for developing new/ high- tech industries, sources of new/high technologies for traditional industries, windows opening to the outside world and test beds for deepening reforms.

At present the establishment of 27 state-run new/high-tech industrial development zones has been approved by the State Council. The zones are located in Beijing, Wuhan, Nanjing, Shenyang, Tianjin, Xi' an, Chengdu, Weihai, Zhongshan, Changchun, Harbin, Changsha, Fuzhou, Guangzhou, Hefei, Chongqing, Hangzhou, Guilin, Zhengzhou, Lanzhou, Shijiazhuang, Jinan, Shanghai, Dalian, Shenzhen, Xiamen, and Haikou.

In addition, the State Council has approved a set of preferential policies for new/ high- tech industrial development zones and formulated methods of classifying enterprises within such zones.

The basic tasks of a development zone are to formulate relevant preferential policies; improve the investment environment; raise funds; establish comprehensive support service systems, and encourage and welcome research institutes, colleges, universities, enterprises and technical personnel to set up new establishments in the zone, create new/ high- tech enterprises, and develop new/high-tech products and industries in accordance with the principles of free grouping, providing funds by oneself, autonomous operation, responsibility for one' s own profits and losses, self-restraint and responsibility for one' s own growth. All these have to be done through deepening the reform drive.

The high- tech pioneering service center is a new type of support service unit for the Torch Programme and the development zones. The basic procedure for such a service center is to "hatching" a project and then foster new/high-tech enterprises and their management. After the successful " hatching" of a project the service center will

的企業和培養出企業的經營管理人員。目前，全國已建立 40 余家高新技術創業服務中心。

3. 組織實施火炬計劃項目

火炬計劃項目實施的出發點和落腳點是，以國內外市場爲導向，以國家、地方和行業的科技攻關計劃、高技術研究發展計劃和其他方面的研究成果、發明、專利爲基礎，擇優評選和組織開發一大批具有先進水平和國內外市場及經濟效益好的高新技術產品，并使之形成高新技術產業。

火炬計劃項目的重點發展技術領域包括：

①新型材料；

②生物技術；

③電子與信息；

④機電一體化；

⑤新能源、高效節能與環境保護；

⑥其它高新技術領域。

列入火炬計劃項目的產品應是技術水平高、經濟效益高、市場前景好，特别是可供出口或替代進口的高新技術產品。這類產品一般投產周期 2—3 年，投入產出比在 1：5 左右，利税率大于 25%，并能形成一定的經濟規模。

火炬計劃項目分國家級和地方級兩級管理。實施火炬計劃的資金主要是銀行貸款，以及地方和各項目承擔單位的自籌資金。此外，國家和地方政府也給予一定的引導資金。

至 1991 年，共組織實施國家級火炬計劃項目 880 個，總投入人民幣 46 億元，美元 1.23 億。項目完成后，預計可新增產值 212.1 億元，年利税 55.1 億元，年創匯 12.3 億美元，年節

proceed to organize a complete, properly scaled enterprise with various types of managers. At present, over 40 high-tech pioneering service centers have been established in different zones.

3. Organizing and realizing projects in the Torch Programme.

Torch Programme is marketing oriented. Most research findings, inventions and patents applied as technological bases in the programme are selected from the achievements of other R&D programmes for their advanced technical level and good economic prospects in both domestic and overseas. The programme is to enable a great number of new/high-tech products to be developed systematically and become industries.

Key technologies for development in Torch Programme projects include:

① New materials;

② Biological engineering;

③ Electronics and information;

④ Mechano-electronics integration;

⑤ New energy, high energy efficiency, energy saving, environmental protection;

⑥ Other new and high technologies.

Products listed in Torch Programme projects should reach a high technical level, have good economic performance and market ability or be capable of being exported or serve as replacements for imported products. Generally it takes two or three years to get such products into production. The ratio of investment and return is approximately 1 to 5, while the profit before tax is greater than 25 percent. Furthermore, such products should reach a certain economic scale.

Torch Programme projects are managed by both state and local authorities. Bank loans and money raised independently by local authorities and those engaged in the projects constitute the bulk of funds for implementing the Torch Programme. The central and local governments allocate a certain amount of money as guidance funds to the projects.

By 1991, 808 state-level Torch Programme projects were organized and implemented with overall investment of 4.6 billion RMB yuan plus 123 million US dollars, and expected to increase annually 21.21 billion RMB yuan in output value, 5.51 billion RMB yuan in profits and taxes, 1.23

匯 11.3 億美元。同期，地方級火炬計劃項目共立項 1903 個，總投入 46.1 億元，項目完成后預計可新增產值 256.9 億元，年利稅 61.6 億元。

4. 推動高新技術產業的國際化

加强國際合作，推動高新技術產業走向國際化道路，是火炬計劃的主要任務之一。火炬計劃國際化的方法是，在平等互利的基礎上，通過政府和民間各種渠道，同世界各國和地區建立廣泛的合作關系，謀求與國外的科技、金融、企業、商業等各界開展多種形式的合作，推動我國高新技術產品進入國際市場和高新技術企業走向國際化道路，促進我國高新技術產業的發展。

5. 培養實施火炬計劃的經營管理人才

實施火炬計劃，發展高新技術產業的關鍵問題之一是人才，包括了解國際高新技術發展狀況、熟悉國際市場和國際貿易的新型科技企業家等多種人才。只有有了這樣的人才，高新技術成果商品化、產業化、國際化才有可能實現。因此，培養一大批懂技術、善管理、會經營、勇于創新、敢于在市場競爭中拼博的科技企業經營管理人才，是火炬計劃的一項重要任務。

billion US dollars in export and to decrease 1.13 billion US dollars import upon their completion. In the meantime, 1903 local-level projects were carried out with investment of 4.61 billion RMB yuan and expected contribution of 25.69 billion RMB yuan in output value and 6.61 billion RMB yuan in profits and taxes.

4. Promoting the internationalization of new/high-tech industries

Enhancing international cooperation and promoting the internationalization of China's new/high-tech industries is one of the Torch Programme's major tasks. The method for internationalizing the Torch Programme is to establish wide cooperative relations with various countries and regions and enter into various forms of cooperation with scientific and technological, financial, enterprise and commercial sectors in foreign countries through governmental or people-to-people channels. The cooperation should be based on equality and mutual benefit, with a view to helping China's new/high-tech products enter world markets, internationalizing China's new/high-tech industries and speeding their development.

5. Training personnel for managing and operating the Torch Programme.

One of the key factors in implementing the Torch Programme and developing new/high-tech industries is competent personnel, including personnel who have at their fingertips knowledge of how the world's new/high technologies are developing, where world markets are heading and how business is done from country to country. New types of engineers and entrepreneurs who have the talent and ability to commercialize, industrialize and internationalize new/high technologies are called for. Therefore, to foster a great number of technical personnel and enterprise managers who understand technology, are good at management and business operation, dare to create and stand out in market competition is a task of paramount importance for the Torch Programme.

星 火 計 劃
SPARK PROGRAMME

計劃的宗旨
Purpose

星火計劃是經中國政府批準實施的第一個依靠科學技術促進農村經濟發展的計劃，是我國科技計劃和國民經濟計劃的一個重要組成部分。其宗旨是把科技火種撒向廣大農村，指導八億農民依靠科技振興農業，引導鄉鎮企業健康發展，推動農村發展以科技爲支柱的社會主義有計劃的商品經濟，推動農業現代化的進程。

Approved by Chinese Government, the Spark Programme is the first programme to be aimed at promoting economic development in rural areas by relying on science and technology. The Spark Programme focuses on spreading R&D findings to the broad rural areas to lead 800 million Chinese farmers developing agriculture, and township enterprises on the basis of science and technology, promoting the development of a planned, socialist, R&D-supported commodity economy in the countryside, and quickening the modernization of agriculture.

計劃的主要內容
Main Contents

星火計劃自 1985 年試點，1986 年正式實施以來，到 1991 年底爲止，全國已安排各級星火示範項目 34691 項，總投資 226 億元，其中：三項費用和各級財政投資占總投資的 6.7%，銀行貸款占 37.6%，企業自籌資金占 55.7%。完成 18175 項，累計新增產值 459 億元，新增利稅 106.5 億元，創匯節匯 33.8 億美元；開發和推出了 100 種適用于發展農村經濟的配套技術裝備，培訓了 890 萬名農民技術人員和經營管理人員。星火計劃爲開發科技第一生產力、提高勞動生產率做出了示範；一批區域性星火支柱產業正在成長壯大，爲引導農村產業

Trail operated in 1985 and officially implemented in 1986, the Spark Programme had, by the end of 1991, organized 34691 demonstration projects across China with a total investment of 22.6 billion yuan, of which 6.7 percent was investment by financial departments at all levels, 37.6 percent was bank loans and 55.7 percent was funds raised by enterprises. The completion of 18175 projects yielded an output value of 45.9 billion yuan, creating 10.65 billion yuan of profit and tax and bringing in US $3.38 billion in foreign exchange. A hundred varieties of technological facilities suitable for rural economy were developed and marketed, and 8.9 million peasants were trained in technology and management. The Spark Programme has demonstrated how to exploit science and

結構調整，完善農村雙層經營體制，促進共同富裕做出了貢獻；着眼農村工業化的總目標，提高鄉鎮企業的技術水平和經營管理能力，引導農村工業走上依靠科技進步和提高勞動者素質的道路；爲解決科技資金投人不足的矛盾，探索出一條使用集資和貸款來組織實施星火計劃的新路子；以引人和培養人才爲核心，促進農村科技體制改革向縱深發展。

technology, and raise work efficiency. A group of mainstay regional Spark industries are now growing up steadily that improve the industrial structure and the management system for common prosperity in rural areas. The main efforts are made on the rural industrialization, including raising the technical skills and management level of village and township enterprises, helping rural industries to develop by relying on advances in science and technology and raising the education level of the workers.

計劃的任務與"八五"期間的目標

Tasks in the Eighth Five-year Plan Period

星火計劃要認真貫徹中國政府關于大力加强農業，促進鄉鎮企業繼續健康發展和深化改革的方針，遵照國務院關于依靠科技進步振興農業，加强科技成果推廣工作的決定。調整產業結構，增加有效供給，推動科技興農。在"七五"的基礎上，提高水平、擴大規模、促進聯合、建立實體、完善服務。爲促進我國農村經濟的持續、穩定、協調發展作出貢獻。

"八五"的總體目標是：通過 300 個區域性重點支柱產業的實施和示範，使科技進步因素在星火計劃的經濟增長作用和星火項目的投資效益方面均有明顯提高，并居于同行業先進行列。五年内星火計劃將圍繞 300 個重點支柱產業安排 1500 個技術開發示範項目，開發 100 種成套星火技術裝備，培訓 500 萬名農村技術人員和管理人員，推廣 100 項成熟配套的星火技術，安排 100 項具有重要開發前景的星

Implementation of the Spark Programme must be guided by the policy of making great efforts to strengthen agriculture, promoting the continued and healthy development of village and township enterprises and popularizing scientific and technical achievements. The industrial structure will be readjusted, necessary supplies be increased and agricultural development be made through science and technology. Based on results achieved during the Seventh Five-year Plan period, the Spark Programme will contribute to a continued, steady and harmonious development of China's rural economy with higher lever, larger scale, more alliances and improved services.

The overall goal of the Spark Programme during the Eighth Five-year Plan is to increase significantly the effects of scientific and technical advances on economic growth and the investment returns of Spark projects through the operation and demonstration of 300 regional mainstay industries and to make them rank among the first few places in their industrial trades. In 5 years the Spark Programme will center on 300 mainstay industries to conduct 1500 technological development demonstration projects, develop 100 varieties of technical equipment packages, train 5 million rural technical and management personnel, popularize 100 mature and integrated technologies, organize

火預備項目，并在“七五”基礎上抓好100個區域綜合開發示範點（星火技術密集區、山區開發及灘涂開發示範點等）。“八五”期間，各地區可根據星火計劃總體目標和本地實際情況安排一批省級及地市縣級星火項目。

“八五”期間，星火計劃按照有利于增加農副產品和短綫產品的有效供給，以當地資源爲原料的深度加工及綜合利用，爲大工業配套服務和增加創匯的原則，重點支持以下九個方面的產業開發：

①種植業及其加工業；

②養殖業及其加工；

③輕工產品；

④紡織產品；

⑤復合肥料；

⑥建材業；

⑦非金屬礦產品及深加工；

⑧爲大工業配套的產品；

⑨農村需用的新型裝備。

100 important preparatory development projects and, based on the Seventh Five-year Plan, manage 100 comprehensive regional demonstration development projects (Spark-technology-intensive zones, mountainous and beach area demonstration development projects and others). During the Eighth Five-year Plan a number of provincial-, municipal-, prefectural-, and county-level Spark projects can be organized in accordance with the overall goal of the Spark Programme and local conditions.

During the Eighth Five-year Plan period the Spark Programme will concentrate on supporting development of the following nine industries, with a view to increasing the supply of agricultural and sideline products, developing fine processing and comprehensive use of local materials, supporting major industries and earning more foreign currency:

① Planting and associated processing;

② Agriculture and associated processing;

③ Light industrial products;

④ Textile products;

⑤ Composite fertilizer;

⑥ Building materials;

⑦ Non-metallic mineral products and fine processing;

⑧ Products to support major industries;

⑨ New types of equipment needed in rural areas.

主要措施

Major Methods of Implementation

1. 以科技進步爲核心，以市場爲導向，開發投資少、見效快的先進適用技術。

2. 以企業自籌和銀行貸款爲主籌集資金，國家給予少量資金引導。國家引導資金實行有償使用。

1. To develop advanced and market oriented technology that suits local conditions, requires less investment and gives guick returns.

2. To collect funds mainly through enterprises and bank loans. The state offers only a small part which is non-gratuitous.

3. In light of local conditions to gradually develop regional mainstay industries by providing guidances to different industrial sectors, setting up

3. 根據因地制宜、分類指導的原則，設置示範項目，引導發展規模經營，逐步形成區域性支柱產業。

4. 國家、省（區）、縣（區）分層次組織實施，實行分級管理。

5. 支持、鼓勵科技人員、科研單位參與星火計劃，建立多種形式的科技生產服務體。動員并依靠社會力量推動星火計劃不斷發展。

demonstration projects and helping to enlarge production scale.

4. Spark Programmes are organized by and implemented at national, provincial (regional), and county (prefectural) levels.

5. Support and encourage scientific and technical personnel and units to take part in organizing and carrying out the Spark Programmes and establish various kinds of service set-ups for scientific and technical production. Mobilize and rely on social forces to constantly develop the Spark Programmes.

國際合作前景

Prospects for International Cooperation

“星火”計劃的實施已經引起世界許多國家特別是發展中國家的關注。聯合國開發計劃署、亞太地區經社組織、世界銀行、歐洲共同體、東歐五國、芬蘭、比利時、印度、巴西、澳大利亞、新西蘭先后同我國進行過政府間接觸。世界銀行支持“星火”計劃的貸款已經簽約生效，首批貸款已完成評估和談判，英國V.S.O(海外志願者服務組織)已選派專家在我國進行技術服務．不少國家邀請我國到他們國家去介紹“星火”計劃。這些說明“星火”計劃的國際使用具有廣闊的前景。

“星火”計劃需得到國際上的支持，許多國家的先進適用技術可供中國開發應用。同樣．“星火”計劃的成功經驗和先進適用技術也可供有關國家借鑒利用。中國有興趣與世界各國建立廣泛接觸，特別是與中小企業進行使用，

Implementation of the Spark Programme has attracted the attention of many countries, especially developing countries. International organizations and foreign countries that contacted the Chinese government include the UNDP, ESCAP, World Bank, European Community, Five Eastern European Countries, Finland, Belgium, India, Brazil, Australia, and New Zealand. The World Bank has signed an agreement to support the Spark Programme, and evaluation and negotiations for its first batch of loans supporting the programme were completed. The British VSO has sent a number of experts to China to provide technical service. Many countries have invited China to brief them on the Spark Programme. All these indicate that the Spark Programme has very good prospects for international cooperation.

The Chinese Spark Programme needs support from the outside world and its successful experience and advanced technologies may be of benefit to other countries conversely. China is interested in establishing ties with other countries, especially in cooperating with small and medium-sized enterprises to develop advanced technology and equipment applicable to small and medium-sized enterprises (village and township

吸收和開發中小企業（鄉鎮企業）所需的先進適用技術和裝備，歡迎朋友們到中國來親自建立樣板。我們也十分樂意在中國或到國外去合作開發和開辦培訓班，爲世界的繁榮進步作出貢獻。

enterprises). We welcome foreign businessmen to establish model enterprises in China. We are also willing to cooperate with foreign friends in developing new projects or running training courses in China or abroad, thus contributing to the prosperity and progress of the world.

國家科技成果重點推廣計劃

NATIONAL S&T ACHIEVEMENTS SPREADING PROGRAMME

計劃的宗旨

Objectives

國家科技成果重點推廣計劃，1990年元月正式出臺。

"推廣計劃"的宗旨是，在社會主義有計劃商品經濟的指導下，充分發揮計劃經濟和市場調節相結合的特點，努力創造良好的環境和條件，有組織、有計劃地將大批先進的、適用的、成熟的科技成果推入國民經濟建設的主戰場，動員廣大科技工作者和全社會力量在農村，在工礦企業中大面積、大範圍內組織實施，盡快形成規模效益，促進國民經濟整體素質的提高，爲實現國民經濟第二步戰略目標而努力奮斗。

The National S&T Achievements Spreading Programme was drawn up in January 1990.

The objectives of the programme are, by taking advantage of the planned economy and market adjustment under the general guidance of the socialist planned commodity economy and by generating optimal conditions, to put advanced, appropriate and mature S&T achievements into national economic construction in an organized and planned way and to mobilize technical personnel and strength from all of society to execute the programme in rural areas, factories and enterprises, in order to produce results in a short time and promote the overall performance of the nation′ s economy, thus realizing the strategic objectives of the second step of the development of the national economy.

計劃的内容

Contents

以形成規模效益爲目標，以傳統産業爲對象，以先進適用成熟的科技成果爲依托，大面積推廣效益好、見效快的科技成果，促進科技、經濟、社會的協調發展。

Aiming at achieving large scale profit in traditional industries on the basis of advanced, appropriate and mature achievements in science and technology, the programme prefers achievements promising higher and quicker returns, in order to facilitate a coordinated development of science and technology, the national economy and society.

計劃實施的政策

Policy Measures for the Implementation

"推廣計劃"的實施特點是：進入産業、多點輻射、形成規模，通過政府的行政干預和有計劃的管理，動員社會各方面的力量，使科技成果在傳統産業和廣大農村變爲現實生産力。

"推廣計劃"實施的政策措施是：

①建立和完善有效的推廣運行機制；

②要將計劃推動與技術市場有機地結合，既發揮計劃對市場的導向作用，又利用技術市場加速成果的擴散；

③以先進適用成熟的技術成果爲依托，以傳統産業爲對象，以形成規模效益爲目標，致力于推動科技成果進入大中型企業和農村；

④實施單位與技術依托單位必須遵循《技術合同法》，堅持技術有償轉讓；

⑤推廣的經費以科技信貸爲主，采取國家引導，地方和實施單位匹配，多渠道籌集的辦法，同時應給予一定的撥款支持；

⑥充分利用現有的科技減免税政策，在物資等支撑條件上，努力開辟渠道。

Characteristics of the programme may be summarized as: entering industry, operating from many localities, formulating scaled production, and encouraging people from all walks of life to transfer R&D achievements to productive forces in the countryside and in traditional industries.

The strategic measures for executing the programme are to:

① Set up and perfect an effective operating mechanism for execution;

② Integrate planning with the technology market to accelerate the dissemination of technology;

③ Transfer advanced, appropriate and mature achievements to large or medium-sized enterprises and the countryside and facilitate scale-efficiency of using such achievements in traditional industries;

④ Follow the Technology Contract Law and market principle;

⑤ Expenses should be covered mainly by scientific loans, supplemented by funds from local governments and executing units under the guidance of the state. Allocations should also be solicited;

⑥ Take full advantage of the policy of tax remission for scientific pursuits to pave new paths for improving support conditions.

計劃實施的步驟

Procedures

全國科技成果推廣計劃，由國家、地方和部門三個層次組成。三個層次的計劃各有側重。國家科技成果推廣計劃是全國科技成果推廣計劃的重點，集中技術力量和資金，推廣具有帶動全局意義的、對國民經濟發展有重大作用的、適用範圍廣、跨行業、跨地區的科技成

The programme is implemented at national, local and sectorial levels. The activities at the three levels complement each other in their distinctive bent and emphasis. Achievements significant to the overall development of the nation's economy and suitable for wide, inter-regional and inter-sector application will be disseminated through the national programme. The

果；部門推廣計劃突出行業的重點，推廣對推動行業發展起"龍頭"作用的科技成果；地方推廣計劃，根據本地區的經濟發展現狀和資源特點，集中力量推廣對振興地方經濟起重大作用的科技成果。

sector's programme should agree with the key points of the province or autonomous region, popularizing achievements that may play a leading role in propelling its development. The local programme, based on current economic development and local resources, should promote achievements conducive to the local economy.

計劃的階段性成果

Phasic Results

1990年國家科委共安排485個重點推廣項目，其中工業196個、農業289個，滾動執行，每年適當補充和調整。

1. 1990年有近50個地方(部門)制定了推廣計劃，重點安排了4000多個項目。

爲了建立新的推廣運行機制，兩年來，國家科委撥款近1500萬元，支持技術依托單位形成以重點推廣項目爲核心的經濟實體或網絡，重點扶植了一批農業項目、工業工藝性項目及社會公益性項目。爲了實施國家級重點推廣計劃項目，1989年、1990年國家共投入貸款4億元，加上地方自籌資金，總投入約12億元。已組織起400多個科研院所、高校的技術依托網絡，吸引和調動了數以萬計的科技人員，輻射到約1000個實施單位，分布在全國41個省區市。1989年安排的近200個實施單位已有約30%初見成效。爲支持地方成果推廣，1990年拿出貸款的30%用于支持地方成果推廣計劃的實施。

2. 初步形成了條塊結合的實施體系。

通過兩年來的實踐，已初步形成國家科委牽頭、有關部門配合，地方科委會同地方廳局實施，技術依托單位全程服務的多層次、條塊結合的實施體系。

——依靠部門，合理布點，確保計劃的有

In 1990 the State Science and Technology Commission approved 485 rolling projects——196 in the industrial sectors and 289 in the agriculture sectors. Adjustments are made annually.

1. Nearly fifty local and sectorial programmes have been worked out and more than 4000 projects are under execution.

In order to formulate a new operating mechanism, the State Science and Technology Commission has allocated nearly 15 million yuan in the last two years to units whose work centers on key popularization projects. Allocations concentrate on projects in agriculture, the manufacturing industry and social welfare. In order to execute key popularization projects at state level, the government allocated 400 million yuan. Taking account of local funds, the total investment amounts to 1.2 billion yuan. A technical network involving some 400 institutions of scientific research and higher learning has been organized and hundreds of thousands of technical personnel have participated in the drive. The number of executing units has reached 1000, scattered in 41 provinces, autonomous regions and municipalities. About 30 percent of the 200 executing units in 1989 have seen results. 30 percent of the funds in 1990 were used to support local projects.

2. An operating system has been set up.

After two years' experience, a multi-level operating system has, under the leadership of the State Science and Technology Commission, been set up on the following bases:

——Effective implementation is guaranteed by rationally selecting the executive units with

效實施，爲跨行業、跨地區推廣科技成果創出新路。

——依靠地方，組織實施，溝通地方科委與廳局、企業（特别是大中企業）的聯系，强化地方科技成果推廣工作。

——依靠技術依托單位，實現技術的擴散。

3. 對深化科技體改革和提高傳統產業技術水平已產生重要作用。

通過計劃的實施，一批科研院所加速了自身發展。政府的組織推動，提高了技術的知名度，疏通了科技成果流向企業的渠道，推動着科研、開發、推廣良性循環機制的形成，給院所和企業帶來新的活力。一批對行業有重大影響的節能、節材、提高經濟效益的項目進入企業后，促進了產業結構和產品結構的調整。

assistance of related departments;

—— Practical organization is strengthened by the cooperation of local government and enterprises;

—— The dissemination of technology relies on technological units.

3. The programme has played an important role in deepening the reform of R&D system and upgrading traditional industries.

The execution of the programme strengthened many research institutions. Government' s planned promotion has enhanced the reputation of technology, facilitated the transfer of scientific achievements to enterprises, created a favorable cycle of research, development and popularization, and invigorated institutions and enterprises. The use of profitable and resource-saving projects has stimulated rectification of the industrial structure and product mix.

"八五"計劃要點

Main Points in the Eighth Five-year Plan Period

"八五"期間，將有 5000 項科技成果逐步滚動進入國家、省（部）推廣計劃，有 15000 項科技成果進入省（區、市）屬市、地、縣，將有 10 萬至 20 萬個實施單位。在計劃完成時，創年產值一千至二千億元以上。投入推廣的科技力量將有 50 萬人。國家級科技成果重點推廣計劃項目在現有 485 項的基礎上，從 1991 年開始，每年將增選 100 項科技成果安排到計劃中，五年内總共安排 1000 項科技成果。"八五"期間將有二萬個企事業單位參加實施。另外，科技成果推廣計劃必須與科技體制改革相配套，與科技政策相協調，與技術市場相結合，與相關科技計劃相銜接，尤其要搞好攻關計

During the Eighth Five-year Plan, 5000 achievements will roll in to national or sectorial level popularization programmes and 15000 in local levels, with 100000 to 200000 units getting involved. Upon accomplishment of the programme, annual output will be increased by 100 billion to more than 200 billion yuan. Some 500000 technical personnel will join the drive for popularization. On the basis of the 485 projects under way, 100 more projects will be selected and added to the state programme annually since 1991, for a total number of nearly 1000 in the next five years. The number of participating units will reach 20000 by the end of this period. It has been ascertained that the programme should coordinate with the constitutional reform and policies of science and technology, with the technological market, and other programmes for science and technology.

In agriculture the emphasis of the programme

劃、“星火”計劃、“火炬”計劃、“軍轉民”計劃以及獲得省(部)級以上獎勵的項目的銜接，它們是成果推廣計劃的后勁所在。

在農業方面，重點推廣糧、棉、油等大田作物的優良品種、增產技術，畜禽飼養技術，農副產品加工技術，綜合治理、生態環境保護，模式化栽培、病蟲害防治、合肥施肥、塑料薄膜覆蓋等爲主的配套技術，及以化肥、農藥、農用薄膜、農業機械等農業生產資料的新品種。

在工業方面，重點推廣一批對能源、交通通信、原材料，機械電子等基礎工業和基礎設施發展有顯著效益的科技成果。推廣對行業調整產業結構，對企業調整產品結構有重要作用的科技成果。推廣對節約能源、節約資源、降低原材料消耗、提高全員勞動生產率有重大影響的科技成果，推廣高新技術向傳統產業擴散和滲透的科技成果，將這些科技成果進行大面積輻射，三至五年內達到技術適用面的25%，努力進入各種形式的技術改造中，使技術改造應用國內先進成熟的比例有比較明顯的增長，促使其降低投資强度，大幅度提高效益。抓好100個新增產值上億元的項目，1000個新增產值千萬元以上的項目。同時推動一批重大效益明顯的典型項目在大中型企業中形成規模效益。

is on popularizing improved seed strains and high-yield technologies of grain, cotton and oil-bearing crops, poultry and animal raising technology, processing sideline products technology, technologies to assist in comprehensive control and biological environment protection, modular cultivation, pest control, rational application of fertilizer, film mulching, and new types of farm production materials, including fertilizers, pesticides, plastic film and farm machinery.

In industry the preference is over projects in energy, communications, raw materials, machinery and electronics that are significant to basic industries and infrastructural facilities, projects of help to the rectification of the industrial structure and product mix, projects leading to energy saving, resource saving, reduced inputs of raw materials and improved production efficiency, and projects suitable for the adaptation of high technology to traditional industries. The influence of the projects is expected to reach 25 percent of the total applicable areas in three to five years. Efforts are also required to translate the achievements into all forms of technical innovation, so as to significantly increase the adoption of mature domestic technologies for technical innovation, reduce investment and increase efficiency considerable. The 100 projects, each with an anticipated increase of over 100 million yuan in net output value, and the 1000 projects, each over 10 million yuan, should be carefully managed, while projects with significant profit should be promoted in large or medium-sized enterprises to achieve mass production.

國家級重點新產品試制鑒定計劃
TRIAL-PRODUCTION AND APPRAISAL PROGRAMME

目標與宗旨
Target and Purpose

新產品開發是促進科技與經濟相結合，促進產業結構升級和產品結構調整，加速產品更新換代，增强企業經濟活力和市場競爭力的重要環節。中國政府爲引導和鼓勵中國境内的企、事業單位積極開發新產品，制定了税收、價格、信貸、進出口、物資和關税等多種優惠政策。《國家重點新產品試制鑒定計劃》就是爲確保這些優惠政策的有效落實而制訂的。

Development of new products is an important link in combining science and technology with the economy, readjusting industrial and product structure, speeding up the development of new products, and rejuvenating the economic performance of enterprises and strengthening their competitive position in the market. In order to guide enterprises and institutions within China and encourage them to actively develop new products, the Chinese government with this programme has formulated a set of preferential policies such as taxes, prices, credit, import and export, materials and customs duties.

内容
Contents

計劃規定：编人計劃的新產品應是采用新技術原理、新設計構思研制生產的科研型（全新型）民用工業產品；或在結構、材料、工藝等某一方面比老產品有明顯改進，從而顯著提高了產品性能或擴大了使用功能的改進型民用工業產品。用進口散件或零部件组裝的國内尚未生產的產品，單純爲軍工配套的產品，傳統手工藝品，以及單純改變花色、外觀、包裝的產品不在此列。

According to the programme, new products listed in the programme should be brand-new civilian industrial products based on new technical principles, new concept, new design, or improved versions that are significantly upgraded from the old version in structure, material quality and manufacturing technology, thus raising product quality to a much higher level. The programme does not include products assembled with imported components or parts, purely for military uses, traditional handicrafts, or those changed only in size, colour, appearance and packaging.

新產品按地域劃分爲國家級新產品和地區級新產品。在全國範圍内第一次研制生產的新產品爲國家級新產品。在省、自治區、直轄市範圍内第一次研制生產的新產品爲地區級新產品。

從企、事業單位開發的新產品中，有重點地篩選其中符合國家级新產品條件的項目，編入計劃，并由國家科委下達。

列人國家重點新產品試制鑒定計劃中的項目，一般都是已進行了技術鑒定（或當年要組織鑒定）并有一定批量生產的新產品。

計劃項目的篩選標準是：

・符合國家產業政策、技術政策、技術裝備政策、產品結構調整和發展方向、并有顯著的經濟效益和社會效益；

・在國内首次試制并達到國内先進水平；

・產品的技術指標達到現行國際標準或同年代國外同類產品的先進性能指標；

・在國際同行業或同類產品中居于領先地位。

凡符合以下條件之一的新產品，優先納人國家级試制計劃：

①支援農業的新產品；

②在節約能源或原材料，充分利用資源，提高交通運輸能力，改善生態環境等方面效益顯著的新產品；

③具有替代進口，出口創匯或增加國内市場有效供給的新產品；

④在中國（外國）專利或獲得國家（國際）發明奬的成果基礎上開發的、能充分發揮我國技術、資源優勢的新產品；

⑤通過引進國外智力的方式，引進、消化、

New products are classified as state level or regional level. New products developed and produced nation wide for the first time are state-level new products. New products developed and produced for the first time in a province, an autonomous region or a municipality are regional-level products.

New products developed by enterprises and institutions will be examined and those meet the requirements of state-levels will be identified and listed in the national programme by the State Science and Technology Commission.

Generally, items listed in the programme are new products that have already been appraised technically (or will be appraised in the current year) and are in moderate mass production.

Criteria for programme-listed products:

—— Conform to government policies for industrial, and technological and technical equipment, the readjustment of product structure and development trends and are capable of producing obvious economic and social benefits;

—— Are trial produced for the first time and have reached advanced levels in China;

—— Have reached current international standards or advanced levels of similar foreign products of the same year in technical specifications;

—— Occupy a leading position in the trade or compared with similar products in the world.

New products that meet one of the following requirements will be listed in the programme as national priorities:

① Support agriculture;

② Are highly efficient in saving energy and raw materials, make full use of resources, increase transportation capability and improve the environment;

③ Can substitute for imported products, be exported and fetch foreign currencies and increase effective supplies in the domestic market;

④ Are developed using patents registered in China or abroad or on the basis of inventions that have won prizes at home or abroad and have brought into full play the advantages of China's technology and resources;

⑤ Are developed using advanced foreign

吸收和應用國外先進技術開發的新產品；

⑥國內高技術領域研究成果商品化和附加價值高的新產品。

technology or design or equipment introduced from abroad;

⑥ Are the commercialization of high-tech research findings and have high added value.

扶持政策與措施

Policies and Measures

國家稅務局根據國家级試制計劃，按照新產品減免稅的有關規定，選擇項目编制下達國家級新產品減免稅名單，同時作出減免產品稅或增值稅的具體規定。

凡列人國家級試制計劃、屬于國家定價的生產資料類新產品試銷期爲三年；民用消費類新產品試銷期爲二年。對于技術難度大，試制期較長的重大新產品，由國務院主管部門提出申請，報國家科委綜合平衡并經國家物價局批準后，可適當延長試銷期。在試銷期内，除特定品種需報物價部門定價外，企、事業單位可以根據試制成本，參照同類產品價格制定試銷價格，報同級物價部門根據規定的作價原則提出建議，報物價部門核定正式價格。

中國工商銀行將國家級試制計劃作爲發放科技開發貸款的指南，各地工商銀行在選擇科技貸款項目時優先考慮，按照科技開發貸款的有關政策規定擇優支持。對企業、開發型科研院所、科研生產聯合體和實行獨立核算的事業單位的重點新產品試制中所需的流動資金，在銀行信貸資金供應能力允許的條件下，給予積極支持。

承擔國家級試制計劃中能出口創匯的新產品試制的企、事業單位，在完成各承包上繳中央外匯基數任務的前提下增加的出口創匯，可參照國家規定的超基數出口外匯留成辦法

The National Tax Bureau is responsible for formulating and publicizing the lists of state-level new products whose taxes are to be reduced or remited in accordance with the programme and regulations on Tax Reduction and remission for New Products.

A promotion period of three years is given to new products categorized as means of production listed in the programme and priced by the state; a promotion period of two years is given to new civilian consumer goods. However, the promotion period can be prolonged for important ones that are technically sophisticated, on the request from the relevant department, balancing by the State Commission of Science and Technology and approval by the State Pricing Bureau. During the promotion period promotional prices of all goods except those in special categories may be decided on the bases of trial production cost and similar goods after approval by pricing departments at the same level.

The China Industrial and Commercial Bank (ICBs) takes the programme as its guideline for priorities of technology development loans. The bank should actively supply the circulating capital needed by enterprises, product-developing research institutes, R&D centres factory complexes and independent accounting institutions in their trial production of key new products.

Enterprises and institutes contracted to trial-produce new products in the programme for export that have earned more foreign currency than expected may retain a certain proportion of the surplus foreign currency in accordance with relevant state regulations after they have turned over to the state the amount of foreign currency

分成。

在國家級試制計劃中爲國家重點計劃配套的項目，各部門和各地方物資部門對所需物資，按現行物資體制的規定給予積極支持。

列入國家級試制計劃的項目，所需進口的原料、加工成產品再出口的，按進料加工的有關規定辦理手續，并盡量給予方便。

國家每年從列入國家級試制計劃項目中選擇若干需要派出國培訓進修和引進國外人才的項目，列入全國重點派出培訓進修計劃和引進國外人才計劃。

對在承擔國家級試制計劃項目中做出突出貢獻的直接設計、試制、管理者，優先獎勵晉升工資。

在實施上述各項扶持政策時，將優先考慮給予科研型新產品較大優惠。

specified in the contract.

Relevant departments, including local material departments, will actively support items in the programme used in key national programmes, in accordance with current regulations for material management systems.

Relevant procedures will be simplified and facilitated for items in the programme requiring imported materials and components that will be processed and assembled for reexportation, in accordance with regulations for importing materials for processing.

The government annually selects some items from the programme for which Chinese personnel will be sent abroad for training and study or foreign engineers will be invited to work in China. These items are listed in the key national programmes for training Chinese personnel abroad and inviting foreign experts to work in China.

Personnel directly engaged in the design, trial production, and management of items in the programme who have contributed outstanding work will take precedence in receiving awards and promotion.

In implementing the above- mentioned policies, priority will be given to the preferential rights of new R&D -type products.

實施的方法與步驟

Methods and Steps of Implementation

國家級試制計劃下達后，分別由各地方、各部門組織實施。

1. 由各地方科委會同人事、勞動、物資、引進智力辦、税務、物價、技術監督、工商銀行等部門負責各項優惠政策的組織落實。部門申報的項目，由有關部門（或地方的有關廳、局）協助項目所在地方科委落實。

2. 由申報地方或部門負責定期檢查項目的試制進度，并督促其達到預期目標。

The National Programme will be organized and implemented by various local departments.

1. Local science and technology committees, together with departments of personnel, labour, materials, taxation, prices, and technical supervision and ICBs, will be responsible for organizing and implementing various favourable policies. Local authorities will assist local science and technology committees in implementing programme items initiated by relevant departments.

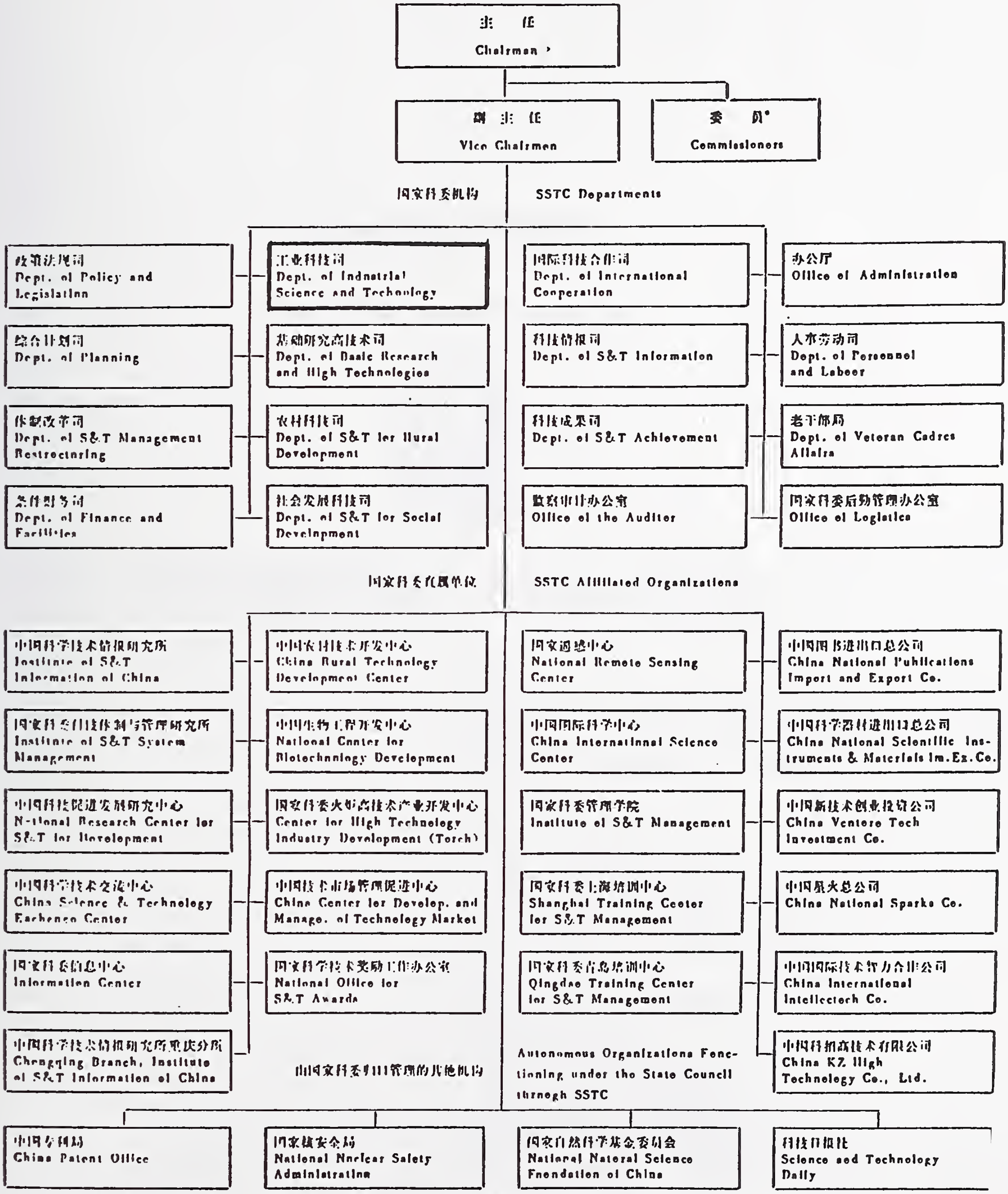
2. Local authorities or departments requesting items will regularly inspect the progress of the item and make sure the programme reaches its expected goal.

3. 組織已完成試產項目的生產定型鑒定(投産鑒定)或驗收，并對試制項目是否具備批量生產（或正式投産）條件作出評價。

3. Local authorities and departments will organize the appraisal or acceptance of trial-produced items and conclude after evaluation whether conditions are available for mass producing the trial-produced item.

中华人民共和国国家科学技术委员会
机 构 图

ORGANIZATION CHART
STATE SCIENCE AND TECHNOLOGY COMMISSION
THE PEOPLE'S REPUBLIC OF CHINA



*国家计委、国家教委、国防科工委、财政部、人事部、中国人民银行、中国科学院、中国科协和国家自然科学基金委员会各一位领导担任。

Appointed respectively from the following organizations, The State Planning Commission, The State Education Commission, The Commission of Science, Technology & Industry for National Defense, The Ministry of Personnel, The People's Bank of China, The Chinese Academy of Sciences, China Association for Science & Technology, and The National Natural Science Foundation of China.

VII. APPENDIX D. 2.

ADVANCED MATERIALS

863 HI-TECH R&D PROGRAM

Advanced Materials

Goals

To develop material science and technology, step up applied research in and development of advanced materials, increase technological innovation, raise product competitiveness and promote the industrialization of advanced materials and related techniques.

Major Contents

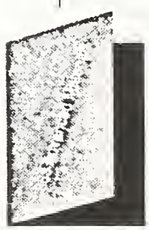
- Advanced functional materials
- High-performance structural materials
- Advanced composite materials
- Modern materials science and technology

Major Areas of Research

- Optoelectronic materials
- Synthetic crystals
- Advanced composite materials
- Advanced ceramic materials
- High-performance metallic materials
- Energy conversion and storage materials
- Materials preparation and evaluation techniques
- Materials design

Organization and Management

The Department of Industrial Technology under the State Science



and Technology Commission is the administrative organ charged with planning this materials program, a research area, and exercises administrative function through the Area Office.

The National Advanced Materials Committee of China (NAMCC), set up by the State Science and Technology Commission, is authorized to be responsible for the organization and execution of the program. The office under the Committee is responsible for daily routine affairs.

The decision—execution—supervision formula is observed in managing the program.

Decision	Execution	Supervision
Joint Meetings	NAMCC	Evaluation Group

Major decisions are made at joint meetings of the Departments of Industrial Technology and the National Advanced Materials Committee.

The NAMCC is in charge of the execution and management of the program.

An Evaluation Group is organized by the Department of Industrial Technology to assess the implementation of the program.

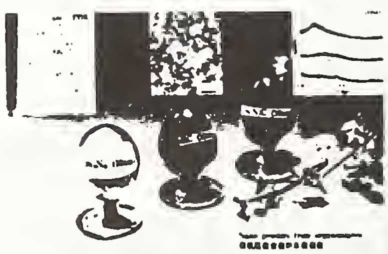
Major Achievements

Optoelectronic semi-conductor materials

● Sixteen types of high- purity metal organic compounds (MO source) are ready for regular production.

● The quality of large-diameter GaSb and InAs monocrystals and their polished films have reached international standards.

● Myriametric antimonide MOCVD and MBE laser and detector materials are up to applicable standard.



LMR Chinese Scince Academy
中国科学院金属研究所

● Marked progress has been made in research in GaAlP/InGaP visible laser detector materials.

Synthetic crystals

● Such synthetic crystals as BBO, EGO, LBO, LAP, KTP and LN have entered the international market on a practical basis.

● In studies on advanced crystal materials, success has been registered in developing such crystals as CBO, KBBF and SBBO.

● Crystals such as Ce:KNSB and Fe:KTN are available for practical use.

● Crystal growth technology and the equipment involved have been successfully developed.

Advanced composite materials

● The performance and especially the storage stability of in-site polymerized thermosetting polyimide resin (PI) has been improved.

● Thermoplastic resins such as PEEK, PPS and PEKK have been developed and are produced on a small scale.

● Glassfiber Mat Thermoplastics (GMT) will be extensively used in the automobile, chemical and sports equipment industries.

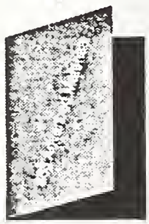
● Manufacturing techniques for B filaments, CVD-SiC filaments and SiC filaments containing titanium have been developed and small-scale production has taken shape. SiC whiskers can be produced on a regular scale.

● Manufacturing techniques for B filaments and aluminum alloy composites reinforced by CVD-SiC fibers have been developed, with product functions up to international standards.

● Aluminum alloy reinforced with SiC whiskers and SiC particles can be produced on a large scale with the prospect of extensive application for the space and automobile industries.

Advanced ceramic materials

● High-performance, low temperature sintered multi-layer ceramic (MLC) capacitor: ceramic materials of low



temperature sintering system with typical Chinese technological characteristics have been adopted, satisfying the demand for high performance and low cost. Ceramic materials of the 2nd category Y5U (2E4) and related materials have been introduced in industry.

- The high temperature behavior of high-performance silicon nitride and silicon carbide ceramics have reached advanced world levels for extensive use in industry.
- The performance of silicon nitride ceramic composite materials toughened with silicon carbide crystal whiskers is up to the international advanced level. The materials have been used for regular scale production of excellent metal cutting and chopping tools, and round cutting blades for stones.
- Ceramic lined steel pipes prepared with SHS technique are produced on a regular scale.

High-performance metallic materials

- Great progress has been made in ordered metallic compounds such as Ni-Al, Ti-Al and Fe-Al materials and in their preparation technology. Special heat treatment increases both the plasticity and fracture toughness of Ti-Al materials and better satisfies application demands.
- Ti-Al and Ti- Al materials are finding a place in the space and aeronautical industries.
- Ni-Al casting materials can stand up to 1100° C and are under consideration for use in aeroplane engines.
- Ni-Al materials reinforced with Ti-C show good high-temperature endurance and resistance to wear. Used as metallurgical machine parts, they can increase the product life span by dozens of times.
- Rapid solidification materials such as Al-Li alloy and Al-Fe alloy are up to applicable standards.

Material surface modification

- Double glow plasma surface alloying technique: This technique gives low cost materials a surface film of special physical and chemical alloys. It has been successfully applied to give plain carbon steel a high-speed steel or stainless steel surface. Breakthroughs have been made in applying the technique to band saw blades. This technique is already in industrial application, and has obtained patent rights in the United States, Canada, Australia, Britain and Japan.
- The metal ion implantation technique using MEVVA source has undergone rapid progress. The life span of MEVVA source enjoys a leading position in the world. This technique has now been applied to surface modification of space parts and molds.
- The development of an experimental machine for omnibearing ion implantation, so-called plasma source ion implantation, has been completed. Research in and development of an industrial prototype machine is underway.
- A high-quality diamond-like film has been developed by using ion beam enhanced deposition. These diamond- like films can be used on different material substrates for near resistance.

Diamond film

- CVD techniques for forming diamond films by using hot filament, microwave plasma, electron beam assisting deposition and direct current plasma jet have been developed, capable of rapid deposition of large areas of high-quality diamond film.
- A technique of forming thick diamond films has been found. Their application in cutting tools and as thermoconductive isolating materials has made progress.
- Studies have also been made on the application of diamond films in acoustic, optical and semi-conductor parts.

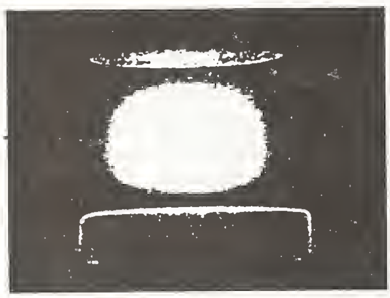
Energy storage materials

- Nickel-hydrogen battery: There has been success in developing high-performance hydrogen storage materials and surface wrapping techniques which have obtained patent registration in China and the United States. A series of nickel-hydrogen batteries have been developed and are in regular production. These batteries do not contain such harmful substances as mercury and cadmium, do not pollute the environment and have large capacities. They are ideal products to replace nickel-cadmium batteries.

● Lithium ion battery: Research in its components has been conducted and prototypes have been produced. These batteries are functioning well and will soon reach the market.

● Sodium-sulfur battery: Breakthroughs have been made in its composition to increase the life span of the battery.

● The application of hydrogen storage materials to heat pumps and for refrigeration has undergone breakthroughs. Special-use hydrogen storage materials have been developed.



Organic optoelectronic materials

● Organic photoconductor drum: High-sensitivity and low-persistent electric potential organic photoconductors and high-sensitivity and high - resolution ratio photoconductor drums have been developed.

● Organic laser disk: Static and dynamic tests of organic photochromic materials have been completed. The write-in degrees under different rotation speeds are all below 23 db. With the quality of the images on the laser disk better than those on the phase transformation disk, the product is near readiness for the market.

Material preparation and processing techniques

● The technique for preparing nano-scaled ceramic powders has been developed and mastered.

● A number of rapid solidification techniques have been established and the production facilities with an annual production capacity of a hundred tons of superfine aluminum powder and a hundred tons of Al-Pb powder have been installed.

- A monocrystal growth oven with YAG pulling method has been developed.
- In microwave sintering, the uneven heat phenomenon has been eliminated by improved energy distribution. Research in and development of the facilities for continued microwave sintering of ceramic rollers have been completed.
- Superplasticity of Al-Li alloys and particle reinforced aluminum-based composite materials, and the superplastic forming techniques of these materials have undergone great development, with the formed parts already applied in the space and aeronautical industries.

Material design

- Expert systems for pattern identification, expert systems using neutral network, computation of phase diagrams and simulation systems for materials design have been developed and applied.
- Design and computation of advanced materials on the level of molecule and atom have been conducted, e.g., computation of the relationship between the molecular orientation and the electronic structure of C60 two-dimensional molecular-packaging materials, forecasting and explaining the STM test results of related materials.
- Major progress has also been made in the design and preparation of nano-scaled materials, and in their dimension. surface and interface effects.

International Cooperation

Since the commencement of the plan, close international cooperativer relations have been established in various ways with many research institutions in Europe, North America and Asia. Various scientific-technical symposia have been jointly held. Bilateral cooperative research projects have been conducted, including the projects of precision casting of light metal alloy matrix composites with Britain (completed), high-power semi-conductor quantum well laser materials with Russia, the PEEK and other high-performance thermoplastic-based composite materials with Germany, and the crystal and advanced ceramics with the Republic of Korea.

Center and Network

The State United Research and Development Center of Synthetic Crystals
The State Engineering and Development Center for Hi-Tech Advanced Energy Storage Materials
The Experiment and Research Center for Fine Composites
MBE Film Materials Experiment Base

THE HI-TECH R&D PROGRAM OF ADVANCED MATERIALS

Prof. Qi Zongneng, NAMCC

June 19, 1995

National Advanced Materials Committee of China

(NAMCC)

Goals

- Develop material science and technology
- Step up applied research in and development of advanced materials
- Increase technological innovation
- Raise product competitiveness
- Promote the industrialization of advanced materials and related techniques

Major Areas of Research

- Optoelectronic materials
- Synthetic crystals
- Advanced composite materials
- Advanced ceramic materials
- High-performance metallic materials
- Energy conversion and storage materials
- Materials preparation and evaluation techniques
- Materials design

Major Achievements

Optoelectronic semi-conductor materials

- Sixteen types of high- purity metal organic compounds (MO source) are ready for regular production.

- The quality of large-diameter GaSb and InAs monocrystals and their polished films have reached international standards.

- Myriametric antimonide MOCVD and MBE laser and detector materials are up to applicable standard.

- Marked progress has been made in research in GaAIP/InGaP visible laser detector materials.

Synthetic crystals

- Such synthetic crystals as BBO, EGO, LBO, LAP, KTP and LN have entered the international market on a practical basis.

- In studies on advanced crystal materials, success has been registered in developing such crystals as CBO, KBBF and SBBO.

- Crystals such as Ce:KNSB and Fe:KTN are available for practical use.

- Crystal growth technology and the equipment involved have been successfully developed.

Advanced composite materials

- The performance and especially the storage stability of in-site polymerized thermosetting polyimide resin (PI) has been improved.

- Thermoplastic resins such as PEEK, PPS and PEKK have been developed and are produced on a small scale.

- Glassfiber Mat Thermoplastics (GMT) will be extensively used in the automobile, chemical and sports equipment industries.

- Manufacturing techniques for B filaments, CVD-SiC filaments and SiC filaments containing titanium have been developed and small-scale production has taken shape. SiC whiskers can be produced on a regular scale.

- Manufacturing techniques for B filaments and aluminum alloy composites reinforced by CVD-SiC fibers have been developed, with product functions up to international standards.

- Aluminum alloy reinforced with SiC whiskers and SiC particles can be produced on a large scale with the prospect of extensive application for the space and automobile industries.

Advanced ceramic materials

- High-performance, low temperature sintered multi-layer ceramic (MLC) capacitor: ceramic materials of low temperature sintering system with typical Chinese technological characteristics have been adopted, satisfying the demand for high performance and low cost. Ceramic materials of the 2nd category Y5U (2E4) and related materials have been introduced in industry.

- The high temperature behavior of high-performance silicon nitride and silicon carbide ceramics have reached advanced world levels for extensive use in industry.

- The performance of silicon nitride ceramic composite materials toughened with silicon carbide crystal whiskers is up to the international advanced level. The materials have been used for regular scale production of excellent metal cutting and chopping tools, and round cutting blades for stones.

- Ceramic lined steel pipes prepared with SHS technique are produced on a regular scale.

High-performance metallic materials

- Great progress has been made in ordered metallic compounds such as Ni-Al, Ti-Al and Fe-Al materials and in their preparation technology. Special heat treatment increases both the plasticity and fracture toughness of Ti-Al materials and better satisfies application demands.

- Ti-Al and Ti-Al materials are finding a place in the space and aeronautical industries.

- Ni-Al casting materials can stand up to 1100° C and are under consideration for use in aeroplane engines.

- Ni-Al materials reinforced with Ti-C show good high-temperature endurance and resistance to wear. Used as metallurgical machine parts, they can increase the product life span by dozens of times.

- Rapid solidification materials such as Al-Li alloy and Al-Fe alloy are up to applicable standards.

Energy storage materials

- Nickel-hydrogen battery: There has been success in developing high-performance hydrogen storage materials and surface wrapping techniques which have obtained patent registration in China and the United States. A series of nickel-hydrogen batteries have been developed and are in regular production. These batteries do not contain such harmful substances as mercury and cadmium, do not pollute the environment and have large capacities. They are ideal products to replace nickel-cadmium batteries.

- Lithium ion battery: Research in its components has been conducted and prototypes have been produced. These batteries are functioning well and will soon reach the market.

- Sodium-sulfur battery: Breakthroughs have been made in its composition to increase the life span of the battery.

- The application of hydrogen storage materials to heat pumps and for refrigeration has undergone breakthroughs. Special-use hydrogen storage materials have been developed.

Material preparation and processing techniques

- The technique for preparing nano-scaled ceramic powders has been developed and mastered.

- A number of rapid solidification techniques have been established and the production facilities with an annual production capacity of a hundred tons of superfine aluminum powder and a hundred tons of Al-Pb powder have been installed.

- A monocrystal growth oven with YAG pulling method has been developed.

- In microwave sintering, the uneven heat phenomenon has been eliminated by improved energy distribution. Research in and development of the facilities for continued microwave sintering of ceramic rollers have been completed.

- Superplasticity of Al-Li alloys and particle reinforced aluminum-based composite materials, and the superplastic forming techniques of these materials have undergone great development, with the formed parts already applied in the space and aeronautical industries.

Material design

- Expert systems for pattern identification, expert systems using neutral network, computation of phase diagrams and simulation systems for materials design have been developed and applied.

- Design and computation of advanced materials an the level of molecule and atom have been conducted, e.g., computation of the relationship between the molecular orientation and the electronic structure of C60 two-dimensional molecular-packaging materials, forecasting and explaining the STM test results of related materials.

- Major progress has also been made in the design and preparation of nano-scaled materials, and in their dimension, surface and interface effects.

Material surface modification

- Double glow plasma surface alloying technique: This technique gives low cost materials a surface film of special physical and chemical alloys. It has been successfully applied to give plain carbon steel a high-speed steel or stainless steel surface. Breakthroughs have been made in applying the technique to band saw blades. This technique is already in industrial application, and has obtained patent rights in the United States, Canada, Australia, Britain and Japan.

- The metal ion implantation technique using MEVVA source has undergone rapid progress. The life span of MEVVA source enjoys a leading position in the world. This technique has now been applied to surface modification of space parts and molds.

- The development of an experimental machine for omnibearing ion implantation, so-called plasma source ion implantation, has been completed. Research in and development of an industrial prototype machine is underway.

- A high-quality diamond-like film has been developed by using ion beam enhanced deposition. These diamond- like films can be used on different material substrates for near resistance.

Diamond film

- CVD techniques for forming diamond films by using hot filament, microwave plasma, electron beam assisting deposition and direct current plasma jet have been developed, capable of rapid deposition of large areas of high-quality diamond film.

- A technique of forming thick diamond films has been found. Their application in cutting tools and as thermoconductive isolating materials has made progress.

- Studies have also been made on the application of diamond films in acoustic, optical and semi-conductor parts.

International Cooperation

Since the commencement of the plan, close international cooperative relations have been established in various ways with many research institutions in Europe, North America and Asia. Various scientific-technical symposia have been jointly held. Bilateral cooperative research projects have been conducted, including the projects of precision casting of light metal alloy matrix composites with Britain (completed), high-power semi-conductor quantum well laser materials with Russia, the PEEK and other high-performance thermoplastic-based composite materials with Germany, and the crystal and advanced ceramics with the Republic of Korea.

Organic optoelectronic materials

- Organic photoconductor drum: High-sensitivity and low-persistent electric potential organic photoconductors and high-sensitivity and high - resolution ratio photoconductor drums have been developed.

- Organic laser disk: Static and dynamic tests of organic photochromic materials have been completed. The write-in degrees under different rotation speeds are all below 23 db. With the quality of the images on the laser disk better than those on the phase transformation disk, the product is near readiness for the market.

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VII. APPENDIX D. 4.

AN UPDATE OF ADVANCED MATERIALS

R&D IN CHINA, SSTC

by

Dr. Ma Manhe
Deputy Director, Materials Division
Department of Industrial Technology
State Science & Technology Commission

June 19, 1995

1. General Information

Human Resources
R&D Institutions
R&D Programs

2. Outline of Advanced Materials in China

Organization and Management
Personnel and Institutions
Related R&D Programs

3. Prospect of Advanced Materials in China

General Goals
Priority Areas

4. Suggestion on Sino-U.S. R&D Cooperation in Advanced Materials Area

Major Cooperation Areas
Timetable

1. General Information

Human Resources

• Personnel engaged in R&D	680,000
• Scientists & Engineers	380,000
• Personnel in Universities	620,000

R&D Institutions

• Total R&D Institutions	5,446
• Universities	814
• R&D Institutions in Universities	1,802

Geographical Distribution

Beijing	400 Research Institutes
North Eastern	300 Research Institutes
South East	200 Research Institutes

Major R&D Programs

- National Natural Science Foundation
- Material Basic Research Priorities Program
- Key Technology R&D Program
- The Hi-Tech Research and Development Program
- Torch Program
- Spark Program
- National S&T Achievements Spreading Program
- Trial Production and Application Program

Besides the national programs, there are Departmental (ministerial) programs and local state programs to promote focused mission needs and/or local needs.

2. Outline of Advanced Materials in China

- Organization and Management

    R.D.E.P. System

        A network of management system for new materials

    Management System

        A. Administrative Management System
        B. Technical Expert Management System

- Personnel and Institutions Engaged in Advanced Materials R&D

Institutions	400
Personnel	100,000

- Manufacture

Enterprises	1,000
Employee	300,000

- Related R&D Programs

Key Technologies R&D Program

The aim of the program is to pool financial and well-trained human resources to the technologies that is critical to the national economy and social development at present and that will guide and greatly influence the development of the national economy and society in the future.

- Carry out from 1982
- The aim of the program
- Organization and management
- Advanced materials is the important area
    - New materials development 35 projects
    - New materials processing 27 projects
    - Materials application 11 projects
    - Engineering Res. Center 9 projects
- Expenditure

  1.78 billion yuan in materials alone

- Achievement

  All ceramic engines (4) have been tested in desert area for 5000 kilometer, another one in Shanghai has 2000 km testing.

The Hi-Tech Research & Development Program

(The 863 Program)

- Background

  March 1986 approved; 7 key technologies, materials is one of them

- Organization and Management

  - Decision - making

    SSTC Industrial Technology and the National Advanced Materials Committees (experts)

  - Execution

    National Advanced Materials Committee

  - Supervision

    SSTC organized evaluation committees

- Main R&D Contents

  - Optoelectronic
  - Crystal
  - Composites
  - Ceramics
  - High performance Alloys
  - Environmental/Energy Materials
  - Materials processing and evaluation
  - Materials design

Torch Program

- Background

  Started in August 1988

- The Aims

  - Commercialization of hi-tech products
  - Establish a hi-tech industry
  - Internationalization of hi-tech industries

- Projects

  Advanced. materials occupy about 25% of the Torch program

- Organization and Management

NEW MATERIALS RELATED PROJECTS

	88-92	93	94	Total
Total Torch Project	1214	298	348	1860
Advanced. Materials	331	84	86	501
%	27.2	28.2	24.7	27
Metals/Alloys	102	22	23	147
Inorganic Non-Metal	78	22	17	117
Organic Polymer	157	40	46	237

National Natural Science Foundation

- To support basic research
- Give above 30% of the fund to new materials area

Distribution of Projects

Topics	%
Metals	29.0
Inorganic Non-Metallic	26.5
Polymer	23.7
Composites	9.5
Others	11.3

3. Future Plans of Advanced Materials in China

- General Goals
    - To develop materials S&T
    - To set up allied research in and development of advanced materials
    - To promote to industrialization of advanced materials and related techniques
- Priority R&D Aspects
    - Electronics materials
    - New materials used on car
    - New energy conversion & storage materials
    - Special functional materials
    - Advanced ceramics and its composites
    - Advanced engineering plastic and polymer matrix composites
    - Advanced metallic alloys and metallic composites
    - Surface and interface technology
    - Materials preparation and evaluation techniques
    - Materials design and its computer modeling

4. Suggestion on Sino-U.S. R&D Cooperation in Advanced Materials Area

- Major cooperation areas
    - Automotive materials
    - High temperature materials
    - Composites
    - Ceramics
    - Polymer materials
    - Metallic materials
    - Materials coating, etc.
- Time table for the cooperation

Jun 1995 - U.S. side finishes visiting China

Sep 1995 - Chinese side finishes visiting America

Nov 1995 - Exchange the cooperation projects drafts respectively

December 1995 - Define the cooperation projects

March 1996 - Implement the projects. Sign Sino-U.S. cooperation protocol in the field of new materials

VII. APPENDIX D. 5.

CHINA'S NEW MATERIALS

Department of Industrial Technology

The State Science and Technology Commission

People's Republic of China

Division of New Materials

Department of Industrial Technology, SSTC

Fuxing Road, Beijing 100862

August 1992

I. GENERAL INTRODUCTION

New materials serve the physical base of human civilization and social development in China, greet attention is raid to the research ,development and utilization of new materials,and to the industrialization of them in particular.

1. New materials are set to be among the key working fields in six major scientific programs being carried out in China, i.t. 'The Hi-Tech R&D' (863) Programme, 'Key Technical Problems' programme, 'Torch' programme, 'Spark' programme and 'National S&T Achievements Spreading' programme. In China's 27 hi-tech development experiment zones, priority is given to the supporting of new materials development, the area into which both the government and private organization have given some considerable input.

2. A more satisfactory system of new materials is beginning to take shape in China. A lot of well-trained scientists specializing in different disciplines are now undertaking all activities from basic research, lab development, applied research and industrialization in the field of new materials, and have created a number of R&D bodies and factories working on them.

3. The State Science and Technology Commission, or SSTC, shoulders the responsibility managing the Sci-Tech work concerning new material, with its Industrial Sci-Tech development, new materials section in charge of day-to-day business. Nearly 20 other State Ministries and Commissions have their own special agencies in charge of the development of new materials within their industrial fields. A huge among of scientific management and service that meets the need of new material development has now shaped up in China.

II. MAIN FRONTIERS AND OUR KEY WORKING FIELDS

Because of new materials involving many different disciplines and specialities, and according to the principle of 'limiting targets, laying stress on priorities, and promoting both innovation and industrial development' We have selected followings as our key working fields:

1. High Performance Composites

*. Thermosetting, thermoplastic resin matrix composites.
*. SiC, Si3N4, ZrO2 and millet ceramic matrix composites.
*. Metal matrix composites, mainly includes Al, Mg, Cu and etc. based metals and alloys.
*. High performance reinforce reagents, includes: carbon fiber, aramide (aromatic polyamide) fiber, high performance glass fiber, boron fiber, SiC fiber, BN fiber and polyethylene etc.
*. Thermosetting & thermoplastic resin matrix (high performance modified epoxy resin,polyamide, PEEK, polyphenylene sulfide) and completed axially and aides.
*. Functionally gradient composites.

2. New Metals

*. High temperature alloys and precision alloys.
*. High strength steel and resist corrosion alloys.
*. Non-ferrous metals, new aluminium-lithium, aluminium-magnesium, high temperature titan alloys and various target materials and special alloys (nickel, beryllium, zirconium, hafnium and etc.).
*. Amorphous materials and processing technology.
Amorphous materials and elements and application development; quenching microcrystal; material of amorphous silicon and his application development technology.
*. Rare earth permanent magnet materials.
New generation rare earth permanent magnets, supermagneto-stretch and magnetic-recording, hydrogen-absorbed, energy-storage materials.
*. Magneto-refrigerating; damping materials, shape-memory alloys.

3. New Organic Materials

*. High performance engineering plastics: polyamide, polyphony sulfides, polysolfones, liquid crystal polymer and polyketones.
*. Engineering plastic alloys and blends.
*. Special organic raw materials and complete aids.
*. organo-silicon monomer and various kinds of silicon oil, silicon rubber (silastic), silicon gel, silicon resins series, new organo-silicon grades and application technology.
*. Processing technology and equipment for new plastic.
*. Organic separating membranes and membrane operating technology. oxygen rich membranes, gas separating membranes, perfluoro ion exchange membranes, ultra-micro filter membranes and re-osmotic membranes, membrane molds and application development.
*. Functionally high molecular materials (electro-magnetic, optical activity and catalytic foundations).

4. High Performance Ceramics

*. Technology for fabricating high-pure and ultra-fine ceramic powder.
*. Technology and processing equipment of high-tech ceramics for forming, sintering and precision process.
*. Technology for evaluation and destructive detecting brittle materials.
*. Research and application development of structure ceramic products: ceramic cutting tool, high temperature sealing valve, bearing and turban-engine components.
*. Sensitive ceramics. various sensitive elements: gas sensitive, hot sensitive, light sensitive to wet, sound sensitive and pressure sensitive.
*. Functionally electronic ceramic.
*. Functionally biological ceramic, artificial bone, teeth, and cardiac valves with biological activity and affinity.

5. Electronic and Optical Materials

*. Semiconductor of silicon, gallium arsenide and indium phosphide compound semiconductor.
*. Non-liner crystals, scintillation crystals and organic crystals and devices.
*. Ultra-pure materials, slurry reagents, special gas and etc.
*. Optical storage, display materials, magnetic-optics, phase shelf and reasonable CD materials.
*. Optical fibers and application.

6. Superconductor

*. Application technology of high temperature superconductor.
*. Low temperature superconductor.
*. Mechanism of high temperature superconductor.

7. Technology for Special Processing and Fabrication Materials

*. Surface modified materials by ion implantation.
*. Thin film technology for modifying surface materials.
*. Research for modifying surface by coating.
*. Special fabrication processing technology, high temperature isostaic pressing, micro wave sintering and laser processing of materials.

8. Science and Technology of Advanced Materials

*. Microstructure design and predicting performance of materials.
*. Research of nanostructure materials.
*. Research of intelligent materials.
*. New material intrinsic, detecting, evaluating method and

technology.
*. Data base and knowledge base of new materials.

III. A PART OF CHINA'S INSTITUTES AND ENTERPRISES IN THE FIELD OF ADVANCED MATERIALS

NAME OF INSTITUTEs	TEL. & FAX.	ADDRESS
China New Chemical MAterials Corporation	TEl.4234501 Fax.4213469	Qiqu Hepingli Beijing, 100013
China Scientific & Technological Industrial Corporation of Inorganic Non-metallic Materials	Tel.8329607 Fax.8311497	Baiwanzhuang, Beijing, 100831
China Nonferrous New Metals Corporation Limited	Tel.8498888ext Fax.8498866	6# Baishiqiaolu Beijing, 100873
China Academy of Building Materials	Tel.5761331 Fax.5761713	Guanzhuang Beijing 100024
Institute of Semiconductor Academia Sinica	Tel.2558131 Fax.2562381	Qinghuadonglu Beijing, 100083
Shanghai Institute of Advanced Ceramics, Academia Sinica	Tel.2512990 Fax.2513930	1295# Dingxilu Shanghai, 200050
Institute of Chemistry Academia Sinica	Tel.2552281 Fax.2569564	Zhongguancun Beijing, 100080
Institute of Metals Research Shengyang, Academia Sinica	Tel.383531 Fax.391320	72# Wenhualu Shengyang 110015
Development Center of Desalination and Water Treatment Technology, The State Oceanic Administration	Tel.876924 Fax. ****	Xixihe Wensanlu Hangzhou, 310012
Beijing General Research Institute of Steel and Iron	Tel.8312255 Fax.8312144	Xizhimenwai Beijing, 100081
Beijing General Research Institute for Nonferrous Metals	Tel.2014488 Fax.2015019	Xinjiekouwaidajie Beijing, 100088
Beijing Research Institute of Materials and Technology	Tel.8383286 Fax.8383563	Donggaodi Beijing 100076
Beijing Institute of Aeronautical Materials	Tel.2556622 Fax.2558529	P.O.box 81 Beijing, 100095

NAME OF INSTITUTES	TEL. &FAX.	ADDRESS
Beijing FRP Research and Design Institute	Tel.3023011 Fax.9744804	Kangzhuang Yanqing Beijing 102101
Beijing Research Institute of Synthetic Crystals	Tel.5762966 Fax.5762871	P.O.Box 733 Beijing 100018
Beijing Municipal Chemical Industries Research Institute	Tel.2563332 Fax.2567814	P.O.box 2653 Beijing, 100084
Beijing Science and Technology University	Tel.2019944 Fax.2017283	30# Xueyuanlu Beijing, 100083
Beijing glass Research Institute	Tel.7019068 Fax.5112478	Congwenmenwai Beijing, 100062
Beijing Plastic Institute	Tel.4034448 Fax. ***	47# guloudajie Beijing, 100009
Textile Academy of Ministry Textile Industry	Tel.5014466 Fax.5010837	yingjiafen Beijing, 100025
Beijing Institute of Chemical Technology	Tel.4218855 Fax.4214487	Hepingjiebeikou Beijing, 100029
Shanghai Jiaotong University	Tel.4310310 Fax.4330892	1954# Huashanlu Shnaghai, 200030
Shanghai Iron and Steel Research Institute	Tel.6671911 Fax.3209847	Taihelu Baoshanqu Shanghai, 200940
Shanghai Textile Research Institute	Tel.5460011 Fel.3208418	545# Lanzhoulu Shanghai, 200082
Shanghai Synthetic Fiber Research Institute	Tel.2598842 Fax.***	350# Tianmulu Shanghai, 200335
Tsinghua University	Tel.2561144 Fax.2561535	Qinghuayuan Beijing, 100084
Tianjin University	Tel.716444 Fax.318329	Qilitai Tianjin 300072
Crystal Institute Shandong University	Tel.803861 Fax.806403	27# Shandananlu Jinan, 250100
Nankai University	Tel.315960 Fax.344856	Balitai Tianjin 300071

NAME OF INSTITUTES	TEL. & FAX.	ADDRESS
Nanjing Glass fiber Research and Design Institute	Tel.624462 Fax.201475	Andeli, Yuhuaxilu Nanjing 210012
Nantong Experiment Factory of Synthetic Materials	Tel.516168 Fax.517254	Yuelonglu Nantong Jiangsu, 226006
Liming Chemical Industry Research Institute	Tel.336792 Fax.337056	Manglinglu Luoyang Henan, 471001
ChengGuang Chemical Industry Research Institute	Tel.290004 Fax.290124	Zigong City Sichaun, 643201
Guangzhou Research Institute of Nonferrous Metals	Tel.7705629 Fax.7706205	Wushan Guangzhou 510651
Harbin FRP Research Institute	Tel.54671 Fax.54759	54# Hongqidajie Harbin, 150036
Baotou Research Institute of Rare Earth	Tel.54411 Fax.26413	P.O.box1313 Baotou Neimenggu, 014010
Shanxi Iron and Steel Research Institute	Tel.742126 Fax. ***	2# Zhaoyuandonglu Xian, 710077
Northwest Institute for Nonferrous Metals Research	Tel.412222 Fax.412001	P.O.box 71, Baoji Shanxi, 721014
Kunming Institute of Precious Metals	Tel.51589 Fax.51533	Kunming, Yunnan 650221
Yiping Potrochemical General Factory	Tel.2165 Fax. ***	P.O.box 4303 Chongqing, 631323

IV. INTERNATIONAL S&T EXCHANGE AND COOPERATION

Seeing that promoting the development of new materials can be obtained by conducting actively international cooperation and exchange, we have established links with many countries in the field of science and technology cooperation in new materials. We are willing and able with our foreign colleagues to do joint investigation and develop new material technologies on a mutually beneficial basis in sides to make strides forward jointly by learning each other's strong points and make up deficiencies.

VII. APPENDIX D. 6.

BRIEF INTRODUCTION TO

THE STATE KEY LABORATORIES AND

ENGINEERING RESEARCH CENTRES

ESTABLISHED IN UNIVERSITIES OF CHINA

State Education Commission

Beijing, China

1994

Forword

In order to enhance the quality and productivity of research in strategic areas relevant to long-term economic and social development and nurture a body of creative young scientists, the State Planning Commission (SPC) of the People's Repubic of China has established a number of the State Key Laboratories (SKL) in some universities and research institutes since 1984, equiped with advanced equipments and instruments for enhancing basic and applied research. The SKL enjoy priorities given by host. The SKL carry out the reform policy and operate under the guideline of "open,interflow and unity". They undertake key studies development projects and accept scientists both domestic and abroad to do research work as visiting scholars.

Every SKL has its independent academic committee composed of famous scientists with high academic level. The academic committee is responsible for defining academic direction, drafting the guide to programs approving projects to be done and visiting researchers to be accepted and evaluating research acheivements of the SKL.

The SKL funds or subsidizes the research projects approved and accomodates visiting researchers. Most of the SKL have post doctoral programs and enrol-postdoctoral fellows regularly. There are a large of senior researchers with high academic reputation,including major young researchers, who are supervising the research and learning of the graduate students. Visiting researchers who have their own research funds are welcome to use the equipments and other technical conditions of the laboratory to do research works.Young scientists of talent are especially welcome.

Otherwise, the plan of establishing the National Engineering Research Centre (NERC) has been performed from 1992, it aims at accelerating to transfer the research achievements of science and technology into products. By studying and developing the market valuable acheivements of science and technology engineering, NERC continually provides overall and mature techniques and equipments to the enterprises, so as to incerease their competitive ability. There have been established 14 NERCs in universities funded by the SPC.

The intellectural right of the visiting researcher are definitely protected according to the related regulations of the SKL and NERC. The researchers of the SKL launch diversified academic exchange and cooperative research with other institutions both domestic and abroad, and attend or organize international conference actively. The SKL and NERC train specialists to international standards.

This book contains the introduction of 44 SKL, 57 SKL which are of Key Studies Development projects Loan by the world bank and 52 Research Laboratories supported by the State Education Commission (SEDC) of P. R. China, 14 NERC supported by the SPC, Total 153 Laboratories and 14 NERCs.

Welcome person of ideals and integrity in science and technology to join research activities in the SKL and the NERC and to make his great contribution to the development of science and technology.

Welcome domestic and international enterprises, mass organizations and celebrities to establish special funds in the SKL and NERC for supporting the development of science and technology in Chinese Universities.

Department of Science and Technology,
State Education Commission,
Beijing, P. R. China
Nov. 1994

金属基复合材料国家重点实验室

上海交通大学

STATE KEY LABORATORY OF METAL MATRIX COMPOSITE MATERIALS

Shanghai Jiao Tong University

实验室主任： 李鹏兴　教授

学术委员会主任： 吴人洁　教授

实验室主要研究方向和内容

研究各类增强体与不同金属组成的结构型、功能型及智能型复合材料，优化复合工艺，发展复合新工艺，二次加工方法及无损检测技术，研究材料微结构与物理、化学及力学性能间的关系，研究界面层结构及其控制与设计。

实验室通讯地址：

上海华山路1954号上海交通大学
金属基复合材料国家重点实验室
邮编：200030
电话：021-4310310-3585
电报：2513
传真：021-4334241
　　　021-4330892

Director of Lab:

Prof. Li Pengxing

Chairman of Academic Committee:

Prof. Wu Renjie

Main Research Fields:

Study on the structural, functional and intelligent composite materials composed of different classes of metal matrices and reinforcements; optimize and explore new composite technology and detecting technique; develop the relationships between the microstructure and physical, chemical and mechanical properties; study the interfacial structure; control and design for interfaces in composite materials.

Address:

State Key Lab of Metal Matrix Composite Materials, Shanghai Jiao Tong University, Shanghai 200030, P. R. China
Tel: (0086)-021-4310310 Ext 3585 or 2468
Cable: 2513
Fax: (0086)-021-4334241
　　(0086)-021-4330892

材料复合新技术国家重点实验室

武汉工业大学

STATE KEY LABORATORY FOR ADVANCED TECHNOLOGY OF MATERIALS COMPOSITIZATION

Wuhan University of Technology

实验室主任： 袁润章　教授

学术委员会主任： 袁润章　教授

实验室主要研究方向和内容

金属与非金属材料的复合原理与复合技术。超微粒子的特性与制备；金属与非金属材料的原子分子水平上的复合；金属与陶瓷的纳米复合；金属与陶瓷复相材料与梯度材料的研究以及材料复合新技术的研究等。

实验室通讯地址：

武汉　武昌珞狮路14号
武汉工业大学
材料复合新技术国家重点实验室
邮编：430070
电话：027-714448
电挂：5220
传真：027-714448

Director of Lab：

Prof. Yuan Runzhang

Chairman of Academic Committee：

Prof. Yuan Runzhang

Main Research Fields：

The study of the compositization theory and technology between metal and non-metal, including synthesis techniques and characteristics of ultrafine particles; the compositization of metal and non-metal at atom and molecule level; nanophase materials and functional gradient materials of metal and non-metal; advanced technology of materials compositization.

Address

State Key Laboratory of Advanced Technology of Materials Compositization, Wuhan University of Technology, 14 Luoshi Road, Wuchang, Wuhan 430070,
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超硬材料国家重点实验室

吉林大学

STATE KEY LABORATORY OF SUPERHARD MATERIALS

Jilin University

实验室主任： 邹广田 教授

学术委员会主任： 经福谦 教授

实验室主要研究方向：

1. 超硬与多功能新材料的制备科学与技术，着重研究高温高压下超硬材料和新型功能材料；

2. 超高压技术，超高压与高温或低温、超快过程、超微尺寸相结合的极端条件下固体的原子结构、电子能谱、相变和物理性质；

3. 超硬等功能材料的原子与分子设计与仿真。

实验室主要年轻学术骨干：

邹广田 教授
金曾孙 教授
王立中 教授

实验室通讯地址：

吉林省长春市
吉林大学超硬材料国家重点实验室
邮编：130023
电话：0431-8923189 转 2722
传真：0431-8923907
E-mail：Zhoujw@hepc2.ihep.ac.cn

Director of Lab:

Prof. Zou Guangtian

Chairman of Academic Committee:

Prof. Jing Fuqian

Main Research Fields:

1. Science and technology of preparation for superhard materials and new multi-functional materials, especially synthesis of superhard materials and new functional materials under high pressure and high temperature.

2. Atomic structure, electronic spectroscopy, phase transition and physical properties of solids under ultra-conditions combined high pressure and high or low temperature, ultra-fast process and nanosceal.

3. Computer simulation and design of superhard and new functional materials in atomic and molecular level.

Major Young Researchers:

Prof. Zhou Guangtian
Prof. Jin Zengsun
Prof. Wang Lizhong

Address:

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P.R.China
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新金属材料国家重点实验
北京科技大学
STATE KEY LABORATORY OF ADVANCED METALSAND MATERIALS
University of Science and Technology Beijing

实验室主任： 陈国良 教授

学术委员会主任： 王润 教授

实验室主要研究方向：

研究新型金属材料和相关的基础理论，包括：

1. 高比强韧性新型金属结构材料及其复合材料;

2.新型金属功能材料;

3.新金属材料的断裂与环境断裂;

4.相关材料合成加工的新技术;

5. 新金属材料的计算机模拟和辅助设计。

实验室主要年轻学术骨干：

张济山 教 授

林均品 副教授

何 国 博 士

实验室通讯地址：

北京科技大学
新金属材料国家重点实验室
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电话：01-2019944 转 2508
传真：01-2017283
E-mail:CHEN-USTB/UNIV/SEDL.bj.cn

Director of Lab:

Prof. Cheng Guoliang

Chairman of Academic Committee:

Prof. Wang Run

Main Research Fields:

1. High specific strength and duatile advanced metals and its composites.

2. Advanced functional metallic materials.

3. The environmental effects on fracture of advanced metals.

4. New technology and processing for advanced metals and composites.

5.Computer simulation and computer aid design for advanced metals.

Major Young Researchers:

Prof. Zhang Jishan

Assoc.Prof. Lin Junpin

Dr. He Guo

Address:

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稀土材料化学及应用国家重点实验室

北京大学

STATE KEY LABORATORY OF RARE EARTH MATERIALS CHEMISTRY AND APPLICATIONS

Peking University

实验室主任: 黎乐民 教授

学术委员会主任: 徐光宪 教授

实验室主要研究方向:

研究稀土化学与稀土新材料，主要内容包括互相联系的四个方面: 稀土分离的新工艺和工艺优化理论; 稀土固体化学及新材料; 稀土配位化学和稀土生物化学; 稀土物理化学和镧系理论。

实验室通讯地址:

北京市北京大学化学与分子工程学院

邮编: 1000871

电话: 01-2501723

传真: 01-2564095

Director of Lab:

Prof. Li Lemin

Chairman of Academic Committee:

Prof. Xu Guangxian

Main Research Fields:

The main research orientation of the laboratory is on the chemistry and new materials of rare earths. theresearch areas consist of the following four parts: separation chemistry of rare earths, rare earth solidchemistry and new materials, coordination chemistry and biochemistry of rare earths, physical chemistry of rareand theory of lanthanides.

Address:

State Key Laboratory of Rare Earth Material Chemistry and Applications,

Peking University, Beijing 100871, P.R. China

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金属材料强度国家重点实验

西安交通大学

STATE KEY LABORATORY OF MECHANICAL BEHAVIOR OF METALLIC MATERIALS

Xi'an Jiaotong University

实验室主任： 何家文 教授

学术委员会主任： 周 廉 教授

实验室主要研究方向：

研究金属材料脆断、韧断、疲劳断裂及在温度、介质、冲击作用下的强度指标及其与微观组织的关系。金属表面注、渗和涂、镀后的表层力学性能及其与工艺的关系。研究非金属、金属基复合材料和新型无机、有机材料的制备、成分、结构与力学性能的关系。

实验室主要年轻学术骨干：

徐可为　教　授
郑茂盛　教　授
宋晓平　副教授

实验室通讯地址：

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金属材料强度国家重点实验室
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电话：029-3268696
传真：029-3237910

Director of Lab:

Prof. He Jiawen

Chairman of Academ Comittee:

Prof. Zhou Lian

Main Research Fields:

Evaluation and criteria of metallic materials for fracture and fatigue resistance in various environments and at various loading rates, the macro properties are assocoated with micro structure. Mechanical properties of surface modified by implantation and/or diffusion. Processes for non-ferrous metals, metal matrix composites and advanced organic and polymeric materials their constituents are associated with their mechanical properties.

Main Young Researchers:

Prof. Xu Kewei,
Prof. Zheng Maoshenge
Assoc. Prof. Shong Xiaoping

Address:

State Key Lab for Mechanical Behavior of Metallic Materials
Xi'an Jiaotong University, Xi'an 710049, P.R. China
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国家教委应用磁学开放研究实验室
兰州大学
THE RESEARCH LABORATORY OF SEDC OF APPLIED MAGNETISM
Lanzhou University

实验室主任: 杨正 教授

学术委员会主任: 都有为 教授

实验室主要研究方向:

围绕磁记录技术的研究，同时开展其它国民经济所需的、有应用前景的高性能新型磁性材料及器件的研究和开发工作，并通过穆斯堡尔谱学、核磁共振自旋回波波谱学及宏观磁性测量手段研究磁性材料的局域结构和宏观磁性的关系.

实验室主要年轻学术骨干:

肖春涛 教授
周荣洁 教授
赵俊慧 教授

实验室通讯地址:

甘肃省兰州大学磁性材料研究所
邮编:730001
电话:0931-8843000 转 3691
传真:0931-8885076

Director of Lab:
Prof. Yang Zheng

Chairman of Academic Committee:
Prof. Du Youwei

Main Research Fields:

Using the methods of mossbauer effect, nuclear magnetic resonance, spin return waves spectrum and macromagnetic measurements, the relation of local construction of magnetic materials and global magnetism can be studied .

Major Young Researchers:

Prof. Xiao Chuntao
Prof. Zhou Rongjie
Prof. Zhao Junhui

Address:

Research Institute of Magnetic Materials,
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国家教委超细材料反应工程开放研究实验室

华东理工大学

THE RESEARCH LABORATORY OF SEDC OF ULTRAFINE PARTICLE AND NEW MATERIALSREACTION ENGINEERING

East China University of Science & Technology

Fax:(0086)-021-5493232

实验室主任: 胡黎明 教授

学术委员会主任: 汪家鼎 教授

实验室主要研究方向:

1.超细颗粒制备科学基础理论;

2. 超细颗粒制备的工程基础研究与反应器开发;

3.超细颗粒应用基础研究;

4. 超细颗粒制备的单元操作理论及粉体工程研究。

实验室主要年轻学术骨干:

古宏晨 副教授

郑柏存 副教授

顾燕芳 副教授

实验室通讯地址:

上海市华东理工大学
超细材料反应工程实验室
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电话:021-4394280 转 3884
传真:021-4705029

Director of Lab:

Prof. Hu Liming

Chairman of Academic Committee:

Prof. Wang Jiading

Main Research Fields:

1. Basic theory of ultrafine particles preparation.

2. Engineering study and reactor development of ultrafine particles synthesizing process.

3. Application fundamental study of ultrafine particles and related new materials.

4. Unit operation theory and ultrafine powder engineering study.

Major Young Researchers:

Assoc. Prof. Gu Hongchen

Assoc. Prof. Zheng Baicun

Assoc. Prof. Gu Yanfang

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国家教委先进材料开放研究实验室

清华大学

THE RESEARCH LABORATORY OF SEDC OF ADVANCED MATERIALS

Tsinghua University

实验室主任:李恒德 教授

学术委员会主任:熊家炯 教授

实验室主要研究方向:

高密度电子封装材料、生物材料、薄膜材料、功能高分子材料、液晶高分子材料、新型贝氏体钢、特种石墨材料以及材料表面改性和设计。

实验室主要年轻学术骨干:

梁开明 教授
于 建 教授
潘 峰 博士

实验室通讯地址:

北京清华大学材料所
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电话:01-2561144 转 2758
传真:01-2562768

Director of Lab:

Prof. Li Hengde

Chairman of Academic Committee:

Prof. Xiong Jiajiong

Main Research Fields:

Materials for high density electronic package, biological materials, thin film, functional polymers, liquid crystal polymers, bainitin steel, special graphite, modification of materials surface, materials design.

Major Young Researchers:

Prof. Liang Kaiming
Prof. Yu Jian
Dr. Pan Feng

Address:

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凝固技术国家重点实验室
西北工业大学
STATE KEY LABORATORY OF SOLIDIFICATION PROCESSING
Northwestern Polytechnical University

实验室主任：杨根仓 教授

学术委员会主任：周尧和 教授

实验室主要研究方向：

1.晶体生长和凝固过程的基础研究；

2.深过冷、快速凝固与定向凝固技术；

3.优质铸件与铸锭的冶金质量控制；

4.以凝固技术为基础的新材料开发。

实验室主要年轻学术骨干：

黄卫东　教授
介万奇　教授
周万成　教授

实验室通讯地址：
西安市西北工业大学
凝固技术国家重点实验室
邮编：710072
电话：029－5253351 转 3283
传真：029－5250199

Director of Lab:

Prof. Yang Gencang

Chairman of Academic Committee:

Prof. Zhou Yaohe

Main Research Fields:

1. Fundamentals research of crystal growth and solidification processing.

2. Deep undercooling, rapid solidification and directional solidification processing.

3. Metallurgy in the production of precision casting and ingot.

4. Modern materials lased on solidification processing.

Major Young Researchers:

Prof. Huang Weidong
Prof. Jie Wanqi
Prof. Zhou Wancheng

Address:
State Key Laboratory of Solidification Processing, Northwestern Polytechnical University,
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理论化学计算国家重点实验室

吉林大学

STATE KEY LABORATORY OF THEORETICAL AND COMPUTATIONAL CHEMISTRY

Jilin University

实验室主任： 孙家钟 教授

学术委员会主任： 唐敖庆 教授

实验室主要研究方向：

1. 新型有机分子、无机分子、高分子和固体材料化学键本质的研究，开展新型分子和材料设计；

2.探索新型能源物质的结构和性质；

3.开展生命科学中化学问题的研究；

4. 量子化学基础理论研究和新计算方法的开拓。

实验室主要年轻学术骨干：

李泽生 教授

张红星 教授

黄旭日 教授

实验室通讯地址：

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邮编：130023

电话：0431-8923189 转 3733

传真：0431-8923907

Director of Lab:

Prof. Sun Chiachung

Chairman of Academic Committee:

Prof. Tang Auchin

Main Research Fields:

1. To investigate chemical bonds of new organic and in organic molecules, polymers and solid state materials and to develop molecular disign and material design.

2. To explore new energy source matter and to investigate their structures and propertiers.

3. To investigate chemical problmes in biology

4.To investigate basic theory in quantum chemistry and to developnew computational techniques.

Major Young Researchers:

Prof. Li Zesheng

Assoc. Prof. Zhang Hongxing

Assoc. Prof. Huang Xuri

Address:

The State Key Lab. of Theoretical and Computational Chemistry,

JiLin University ,

Changchun 130023, P.R. China

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吸附分离功能高分子材料国家重点实验室

南开大学

STATE KEY LABORATORY OF FUNCTIONAL POLYMER MATERIALS FOR ADSORPTION AND SEPARATION

Nankai University

实验室主任: 黄文强 教授

Director of Lab:
Prof. Huang Wenqiang

学术委员会主任: 何炳林 教授

Chairman of Academic Committee:
Prof. He Binglin

实验室主要研究方向:

高效吸附分离功能高分子材料的设计合成、结构、性能、作用机理及应用的研究，开展与其它学科相交叉的基础研究和应用基础研究，开发新一代的高效、专一吸附分离功能高分子材料。

Main Research Fields:

The research emphasis on design and synthesis of functional and separation, characterization of structure,performance and interaction mechanism of these functional materials in application, and in addition, opening up to the cross base research and application baseresearch with other related subjects, developing new generation of highly efficient and special function polymer materials for adsorption and separation.

实验室通讯地址:

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State Key Laboratory of Functional Polymer Materials for Adsorption and Separation,
Nankai University,
Tianjin 300071, P.R.China
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国家教委聚合物分子工程开放研究实验室
复旦大学
THE RESEARCH LABORATORY OF SEDC OF MOLECULAR ENGINEERING OF POLYMERS
Fudan University

实验室主任: 杨玉良 教授

学术委员会主任: 江明 教授

实验室主要研究方向:

1. 高分子聚集态在分子水平上的结构及高分子材料宏观性能的关系;
2. 特殊相互作用与相容性,自组装行为和凝聚态形态及高分子共混物材料等;
3. 高分子分子设计。

实验室主要年轻学术骨干:

陈文杰 博士
邵正中 博士
丁建东 博士

实验室通讯地址:

上海复旦大学高分子科学系聚合物分子工程开放实验室
邮编:200433
电话:021-5346405
传真:021-5493232

Director of Lab:
Prof. Yang Yuliang

Chairman of Academic Committee:
Prof. Jiang Ming

Main Research Fields:

1. Structure at molecular lever of condensed state and the relationship between the structure and the properties of polymer materials.
2. Specific interactions and miscibility, self-assembly behavior and morphology of condensed state,blend materials.
3. Molecular design of polymers.

Major Young Researchers:

Dr. Chen Wenjue
Dr. Shao Zhengzhong
Dr. Ding Jiandong

Address:

The Laboratory of molecular engineering of polymers, Dept. of Macromolecular Sci. Fudan University,
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高分子材料工程国家重点实验室

四川联合大学

STATE KEY LABORATORY OF POLYMER MATERIALS ENGINEERING

Sichuan Union University

实验室主任: 徐僖 教授

学术委员会主任: 何炳林 教授

实验室主要研究方向:

1. 多组分多相高分子材料的结构与性能、复合机理、增容机理;
2. 聚合物加工基础理论;
3. 新技术在高分子材料制备及加工中的应用。

实验室主要年轻学术骨干:

王 琪 教 授
郭少云 副教授
刘白玲 副教授

实验室通讯地址:
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高分子材料国家重点实验室
邮编:610065
电话: 028-5213465
传真: 028-5213465

Director of Lab:
Prof. Xu Xi

Chairman of Academic Committee:
Prof. He Binglin

Main Research Fields:

1. Studies on multicomponent and duliphase polymer systems.
2. Studies on polymer procesing, theories and related technologies.
3. Studies on new techniques applicable to fabrication and processing of polymer materials.

Major Young Researchers:

Prof. Wang Qi
Assoc. Prof. Guo Shaoyun
Assoc. Prof. Liu Bailing

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国家教委聚合物复合材料及功能材料开放研究实验室
中山大学
THE RESEARCH LABORATORY OF SEDC OF POLYMERIC COMPOSITE AND EUNCTIONAL MATERIALS
Zhongshan University

实验室主任: 章明秋 教授

Director of Lab:
Prof. Zhang Mingqiu

学术委员会主任: 徐 僖 教授

Chairman of Academic Committee:
Prof. Xu Xi

实验室主要研究方向和内容:

1. 聚合物多相复合体系的结构与性能及聚合物复合材料的研究和应用;
2. 新型纤维状功能材料研究及其应用技术。

Main Research Fields:

1.Structure-property of polymeic mutil-phase systems and composite and their applications.

2.Study of new ecomaterials and their applications.

实验室主要年轻学术骨干:

许家瑞 教 授
麦堪成 副教授
符若文 副教授

Major Young Researchers:

Prof. Xu Jiarui
Assoc. Prof. Mai Kancheng
Assoc. Prof. Fu Ruowen

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硅材料国家重点实验室

浙江大学

STATE KEY LABORATORY OF SILICON MATERIALS

Zhejiang University

实验室主任：姚鸿年 高级工程师

Director of Lab：

Senior Engineer Yao Hongnian

学术委员会主任： 林兰英 教授

Chairman of Academic Committee：

Prof. Lin Lanying

实验室主要研究方向和内容：

高纯近本征硅单晶的研究；微氮直拉单晶基础理论、微观结构、生长机制与硅氮反应动力学、电学与力学行为的研究；微氮硅单晶 IC 硅片的性状研究；颗粒状多晶硅基础理论研究；硅烷外延与硅表面科学的研究。

Main Research Fields

The study of high-purity near intrinsic single crystal silicon; CZ single crystal silicon containing trace amount of nitrogen, including: basic theory, micro-structure; growth mechanism and Si-N reaction dynamics, electrical and mechanical behaviors; characteristics of single crystal silicon containing trace amount of nitrogen for IC uses; basic theoretial research of granular poly-crystal silicon; epitaxial growth of silicon with silane; the study of surface and interface of silicon material.

实验室通讯地址：

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传真：0571-571792

Address:

State Key Lab of High Purity Silicon

Zhejiang University, Hangzhou 310027

P. R. China

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新型陶瓷与精细工艺国家重点实验室

清华大学

STATE KEY LABORATORY OF NEW CERAMICS AND FINE PROCESSING

Tsinghua University

实验室主任：李龙土 教授

学术委员会主任：姚熹 教授

实验室主要研究方向：

开展新型陶瓷材料组成，显微结构、制备技术、物理性能及应用研究。

1.耐高温、高强、高韧结构陶瓷及新工艺，增韧机理及断裂力学；

2.高性能铁电、介电、压电、半导体与导电陶瓷材料及应用，功能陶瓷微结构及缺陷化学；

3.陶瓷基复合材料，晶须补强等复相陶瓷的结构与性能；

4.纳米材料与材料化学，生物陶瓷与仿生材料，烧成新工艺及特种制备技术。

实验室主要青年学术骨干：

黄 勇 教授 李龙土 教授

实验室通讯地址：

北京清华大学材料科学与工程系

新型陶瓷与精细工艺实验室

邮编：100084

电话：01－2594579

传真：01－2562768

Director of Lab:

Prof. Li Longtu

Chairman of Academic Committee:

Prof. Yao Xi

Main Research Fields:

1. Reparing new ceramics with mechanical properties of high temperature, high strength and high toughness, investigating their toughening mechanism and fractural mechanics.

2. Study in advanced ceramics with optimized properties of ferroelectrics, dielectrics, pie electrics, semi – conductuvuty, and conductiruty, microstructures and defect chemistry.

3. Studying structures and properties of ceratmic based composites with whisker reinforced.

4. Materials chemistry, bioceramics, materials bionics, microwave synthesisand simtering, and other special preparation processing.

Major Young Researchers:

Prof. Huang Yong, Prof. Li Longtu

Address:

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国家教委高温结构陶瓷与工程陶瓷加工技术开放研究实验室

天津大学

THE RESEARCH LABORATORY OF SEDC
OF HIGH-TEMPERATURE STRUCTURAL CERAMICS AND
MACHINING TECHNIQUE FOR ENGINEERING CERAMICE

Tianjin University

实验室主任: 徐燕申 教授

学术委员会主任: 袁启明 教授

实验室主要研究方向:

1. 氧化锆增韧陶瓷组成、结构设计和性能优化;
2. 高温结构陶瓷高效低成本制备技术;
3. 工程陶瓷加工技术;
4. 工程陶瓷在机械中的应用。

实验室主要年轻学术骨干:

龚江宏 博士
林 彬 硕士
杨云鹏 博士

实验室通讯地址:

天津市天津大学先进陶瓷研究所
邮编:300072
电话:022-3358116 转 2188

Director of Lab:
Prof. Xu Yanshen

Chairman of Academic Committee:
Prof. Yuan Qiming

Main Research Fields:

1.The design of compositions and structures and optimization of properties for ZrO_2 toughened ceramics.

2.Highly efficient and low-cost manufacturing techniques for high-temperature structural ceramics.

3.Machining techniques of engineering ceramics in machinery.

4.The application of engineering ceramics in machinery.

Major Young Researchers:

Dr. Gong Jianghong
M.Sc. lin Bin
Dr. Yang Yunpeng

Address:

Advanced Ceramics Institute,
Tianjin University,
Tianjin 300072, P.R.China
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国家教委高温材料及高温测试开放研究实验室
上海交通大学
THE RESEARCH LABORATORY OF SEDC OF HIGH-TEMPERATURE MATERIALS AND HIGH TEMPERATURE TESTING
Shanghai Jiaotong University

实验室主任: 吴健生 教授

学术委员会主任: 林栋梁 教授

实验室主要研究方向:

1. 高温结构材料的微观组织结构分析，高温变形机理及断裂过程、循环变形及蠕变机理研究;
2. 高温结构材料的合金设计及工艺设计;
3. 高温结构材料的高温力学性能测试、抗氧化及抗腐蚀性能试。

实验室主要年轻学术骨干:

吴健生 教授
陈世朴 教授
蔡 旬 教授

实验室通讯地址:

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高温材料及高温测试实验室
邮编: 200030
电话: 021-4310310 转 2544
传真: 021-4330892

Directory of Lab:

Prof. Wu Jiansheng

Chairman of Academic Committee:

Prof. Lin Dongliang

Main Research Fields:

1. Microanalysis on the microstructure and the chemistry of high-temperature materials. Studies on mechanisms of the high temperature deformation and processes of microcrack nucleus and propagation, creep and cycle deformations.
2. The alloy design and the technological design.
3. Testing of high-temperature mechanical properties, oxidization resistance and corrosion resistance properties.

Major Young Researchers:

Prof. Wu Jiansheng
Prof. Chen Shipu
Prof. Cai Xun

Address:

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混凝土材料研究国家重点实验室

同济大学，南京大学

STATE KEY LABORATORY OF COCRETE MATERIALS RESEARCH

Tongji University,Nanjing University

实验室主任: 吴科如　教授

学术委员会主任: 黄鼎业　教授

实验室主要研究方向:

1.混凝土力学行为的综合设计,工艺控制,混凝土的合理使用及其改性途径;

2. 水泥 - 集料界面结构的形成过程，控制条件，及其对力学性能的影响;

3. 聚合物混凝土，纤维增强混凝土，高性能水泥基复合材料;

4.混凝土耐久性预报,混凝土质量检测。

实验室主要年轻学术骨干:

王培铭　教授
王新友　教授
张　雄　教授

实验室通讯地址:

上海市同济大学
混凝土材料研究国家重点实验室
邮编:200092
电话:021-5455080 转 3463
传真:021-5458965

Director of Lab:

Prof. Wu Keru

Chairman of Academic Committee:

Prof. Huang Dingye

Main Research Fields:

1.Comprehensive designs for mechanical properties of concrete materials.

2.The characterizations of the interface between cement and aggregate.

3.Polymer concrete.

4.The prediction of the durabilities of concrete.

Major Young Researchers:

Prof. Wang Peiming
Prof. Wang Xinyou
Prof. Zhang Xiong

Address:

State Key Laboratory of Concrete Materials Research,
Tongji University, Shanghai 200092,
P.R. China
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机械结构强度与振动国家重点实验室

西安交通大学

STATE KEY LABORATORY OF STRUCTURAL STRENGTH AND VIBRATION

Xi'an Jiaotong University

实验室主任： 沈亚鹏　教授

学术委员会主任： 黄克智　教授

实验室主要研究方向和内容：

1. 研究机械结构的疲劳和断裂。
2. 机械结构的动力分析、动力修改、实时监控和振动控制。

实验室通讯地址：

陕西省西安市咸宁路
西安交通大学
机械结构强度与振动国家重点实验室
邮编：710049
电话：029-335011 转 3751
电报：2827
传真：029-337910

Director of Lab:

Prof. Shen Yapeng

Chairman of Academic Committee:

Prof. Huang Kezhi

Main Research Fields:

1. The study of the fatigue and fracture of engineering structures in the field of mechanical structural strength.
2. Structural dynamic model modification, in-service monitor and vibration control in the field of mechamical structural vibration.

Address:

State Key Lab of Structural strength and Vibration, Xi'an Jiaotong University,
Xi'an 710049, P.R. China
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工业装备结构分析国家重点实验室

大连理工大学

STATE KEY LABORATORY OF STRUCTURAL ANALYSIS OF INDUSTRIAL EQUIPMENT

Dalian University of Technology

实验室主任: 程耿东 教授

学术委员会主任: 闻邦椿 教授

实验室主要研究方向:

1 大型复杂结构的动力分析、控制和优化;

2. 计算机辅助设计与视算技术;

3 工程结构的可靠性分析、寿命估计和优化设计;

4. 先进材料的高温、疲劳、断裂和冲击特性研究；

5 工业装备结构与材料的静动力学测试与诊断;

6. 环境与工艺力学研究;

实验室主要年轻学术骨干:

顾元宪 教授

吴承伟 教授

张洪武 教授

实验室通讯地址:

大连理工大学工程力学研究所

邮编:116023

电话:0411-4708400

传真:0411-4671009

Director of Lab:

Prof. Cheng Gengdong

Chairman of Academic Committee:

Prof. Wen Bangchun

Main Research Fields:

1. Dynamic analysis, control and optimization of complex structures.

2. Computer aided design and visualized computing.

3. Reliability analysis, life estimation and optimal design.

4. Study on behaviors of advanced materials under high temperature, fatigue, fracture and impact loading conditions.

5. Static and dynamic tests and diagnostics.

6. Study on enviornmental and technological mechanics.

Major Young Researchers:

Prof. Gu Yuanxian

Prof. Wu Chengwei

Prof. Zhang Hongwu

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粉末冶金国家重点实验室
中南工业大学
STATE KEY LABORATORY OF POWDER METALLURGY
Central South University of Technology

实验室主任： 黄伯云 教授

学术委员会主任： 黄培云 教授

实验室主要研究方向：

1. 粉末制取原理与制取新工艺；
2. 粉末冶金材料结构与性能；
3. 新型粉末冶金材料；
4. 成形理论与工艺；
5. 烧结理论与工艺。

实验室主要年轻学术骨干：

黄伯云 教 授
曲选辉 教 授
张树高 副教授

实验室通讯地址：

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中南工业大学粉末冶金研究所
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电话:0731－8883255
传真:0731－8883255

Director of Lab:

Prof. Huang Boyun

Chairman of Academic Committee:

Prof. Huang Peiyun

Main Research Fields:

1. The principles of powder preparation and the new technology of powder production.
2. The structure and property of P/M materials.
3. New P/M materials.
4. Compressing theory and technology.
5. Sintering theory and technology.

Major Young Researchers:

Prof. Huang Boyun
Prof. Qu Xuanhui
Assoc. Prof. Zhang Shugao

Address:

P/M Research Institute, Central South University of Technology (CSUT),
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国家教委破坏力学开放研究实验室
清华大学
THE RESEARCH LABORATORY OF SEDC OF FAILURE MECHANICS
Tsinghua University

实验室主任: 杨卫 教授

学术委员会主任: 黄克智 教授

实验室主要研究方向:

1.材料破坏过程的宏微观力学研究;

2.材料强韧化力学原理研究;

3. 电子材料的失效力学与可靠性研究;

4.多媒体力学实验技术。

实验室主要年轻学术骨干:

杨 卫 教授

孙庆平 教授

郑泉水 教授

实验室通讯地址:

清华大学工程力学系

国家教委破坏力学开放研究实验室

邮编:100084

电话:01-25611444 转 3986

传真:01-2562768

Director of Lab:

Prof. Yang Wei

Chairman of Academic Committee:

Prof. Huang Kezhi

Main Research Fields:

1. Macromechanics and micromechanics studies for the material failure processes.

2. The mechanics principles for the strengthening and toughening of materials.

3. Failure mechanics and reliability of electionic materials.

4. Multi-media techniques for experimental mechanics.

Major Young Researchers:

Prof. Yang Wei

Prof. Sun Qingping

Prof. Zheng Quansui

Address:

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Fax:(0086)-01-2562768

现代焊接生产技术国家重点实验室

哈尔滨工业大学

STATE KEY LABORATORY OF ADVANCED WELDING PRODUCTION TECHNOLOGY

Harbin Institute of Engineering

实验室主任： 王其隆 教授

学术委员会主任： 关桥 教授

实验室主要研究方向：

1.焊接结构的应力、变形、可靠性及非破坏性检验；

2.电弧、等离子弧焊过程、弧焊电源、自动焊接装置及质量控制系统；

3.材料焊接及连接技术；

4.机器人焊接及焊接过程智能控制；

5.激光加工技术及其控制系统；

6.特种焊接技术和压力焊接技术。

实验室主要年轻学术骨干：

王春青 教授
鄂立国 教授
耿 正 教授

实验室通讯地址：

哈尔滨市哈尔滨工业大学
现代焊接生产技术国家重点实验室
邮编：150001
电话：0451－3621000 转 3951
传真：0451－3621048

Director of Lab:

Prof. Wang Qilong

Chairman of Academic Committee:

Prof. Guan Qiao

Main Research Fields:

1. Stress, distortion and reliability of welded construction, nondestructive testing.

2. Arc and plasma welding process, arc welding power supplies and automatic welding equipment.

3. Welding and joining technology of materials.

4. Robotic welding and intelligence control of wdlding processes.

5. Laser processing technology and its control system.

6. Special welding processes and pressure welding technology.

Major Young Researchers:

Prof. Wang Chunqing
Prof. E Liguo
Prof. Geng Zheng

Address:

State Key Lab for Advanced Welding Production Technology, Harbin Institute of Technology, Harbin 150001, P.R.China
Tel: (0086) – 0451 – 3621000 Ext.3951
Fax: (0086) – 0451 – 3621048

集成光电子学国家重点实验室

清华大学 吉林大学 中科院半导体所

STATE KEY LABORATORY OF INTEGRATED OPTOELECTRONICS

Tsinghua University, Jilin University

Institute of Semiconductor, CAS

实验室主任主任：刘式镛 教授

Director of Lab: Prof. Liu Shiyong

学术委员会主任：王启明 教授

Chairman of Academic Committee: Prof. Wang Qiming

实验室主要研究方向及内容：

半导体光电子材料器件；量子尺寸半导体光电子器件；半导体激光器的模式控制及锁模；半导体光双稳态；光电子集成及光子集成；光纤及光波导器件；光电子器件及芯片测试技术；光电子系统及子系统；

Main Research Fields:

Semiconductor optoelectronic materials and devices; quantum size semiconductor optoelectronic devices; mode control and modelocking of semiconductor lasers; semiconductor optical bistability; optical fiber and optical waveguide devices; optoelectronic integration and photonic integration; test and measurement of optoelectronic devices and chips; optoelectronic systems and subsystems.

实验室通讯地址：
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01-2561144-2734
传真：01-2564176

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Department of Electronic Engineering,
Tsinghua University
Beijing 100084, P.R. China
Tel: (0086)-01-2561534
(0086)-01-2561144 Ext 2734
Fax: (0086)-01-2564176

三束材料改性国家重点实验室

复旦大学 大连理工大学

STATE KEY LABORATORY FOR MATERIALS MODIFICATION BY LASER, ION AND ELECTRON BEAMS

Fudan University & Dalian University of Technology

实验室主任： 马腾才 教授

学术委员会主任： 杨福家 教授

实验室主要研究方向和内容：

研究激光束、电子束，离子束和等离子体的物质改性和材料表层优化的机理和工艺。包括：优化涂层的研究、表层合金化研究、载能束作用下材料微观结构变化规律及优化机理的研究。

实验室通讯地址：
上海邯郸路 220 号
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三束材料改性国家重点实验室
邮编：200433
电话：021－5490528
电报：8251
传真：021－3269848

Director of Lab:
Prof. Ma Tengcai

Chairman of Academic Committee:
Prof. Yang Fujia

Main Research Fields:

The study of the mechanism and technology for materials modification and surface optimization by laser, ion, elecrton beams and plasmas. Including the fabrication of films and coatings with high quality, surface alloying, the variation and optimization mechanism for the microstructure of materials under the action of the energy-carrying beam.

Address:
State Key Lab for Materials Modification by Laser, Ion and Electron beams, Fudan University 220 Handan Road, Shanghai 200043, P. R. China
Tel: (0086)-021-5490528
Cable: 8251
Fax: (0086)-021-3269848

晶体材料国家重点实验室

山东大学

STATE KEY LABORATORY OF CRYSTAL MATERIALS

Shandong University

实验室主任：蒋民华 教授

学术委员会主任：闵乃本 教授

实验室主要研究方向和内容：

1. 新功能晶体材料(非线性光学、激光、光折变、热电、压电晶体)的探索和研究。

2. 晶体生长基本过程包括生长机理、热力学、动力学等的研究。

3. 晶体物理性质的研究和晶体品质鉴定。

4. 薄膜晶体材料的研究。

实验室通讯地址：

济南山大南路27号

山东大学晶体材料国家重点实验室

邮编：250100

电话：0531-616404

传真：0531-616404

电报：济南1331

Director of Lab:

Prof. Jiang Minhua

Chairman of Academic Committee:

Prof. Min NaiBen

Main Research Fields:

1. The study of new functional crystal materials, e. g. new nonlinear optical, laser, photorefractive, pyroelectrical and piezoelectric crystal materials.

2. The study of the basic processes of crystal growth including growth mechanism, thermodynamics and kinetics.

3. The study on crystal physical properties and characterization of crystals.

4. The research and development of thin film of crystal materials.

Address:

State Key Lab of Crystal Materials,
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国家教委光电技术及系统开放研究实验室

重庆大学

THE RESEARCH LABORATORY OF SEDC OF OPTOELECTRONIC TECHNOLOGY AND SYSTEMS

Chongqing University

实验室主任：黄尚廉 教授

Director of Laboratory:
Prof. Huang Shanglian

学术委员会主任：金国藩 教授

Chairman of Academic Committee:
Prof. Jin Guofan

实验室主要研究方向：

1.光纤传感与智能结构；
2. 光电集成传感技术与微型机电系统；
3.文字图象识别技术及系统；
4.智能化光电仪器与系统。

Main Research Fields

1. Fiber optic sensing and intelligent structures.
2. Integrated photoelectronics and micromechatronic system.
3. Optical character recognition and image processing.
4. Intelligent instrumentation.

实验室主要年轻学术骨干：

潘保昌 教授
石文江 教授
李建蜀 教授

Major Young Researchers

Prof. Pan Baochang
Prof. Shi Wenjiang
Prof. Li Jianshu

实验室通讯地址：

四川重庆市
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光电技术及系统开放研究实验室
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Address

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国家教委分子与生物分子电子学开放研究实验室

东南大学

THE RESEARCH LABORATORY OF SEDC OF MOLECULAR AND MOLECULAR ELECTRONICS

Southeast University

实验室主任: 陆祖宏 教授

Director of Lab:
Prof. Lu Zuhong

学术委员会主任: 吴全德 教授

Chairman of Academic Committee:
Prof. Wu Quande

实验室主要研究方向:

在功能分子的纳米组装技术，分子层次上能量和信息传递规律，分子光存贮和光开关，分子传感器件，分子设计以及计算原理和系统等方面开展多层次深入的研究。

Main Research Fields:

In-depth research in the areas of nanotechnology in organizing functional molecules, the roles of energy and information transfer in molecular levels, molecular opto-storagers and opto switchers, molecularsensors, molecular design computing principles, etc.

实验室主要年轻学术骨干:

陆祖宏 教授
袁春伟 教授
甘 强 教授

Major Young Researchers:

Prof. Lu Zuhong
Prof. Yuan Chunwei
Prof. Gan Qiang

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Fax:(0086)-025-7712719

国家教委胶体与界面化学开放研究实验室

山东大学

THE RESEARCH LABORATORY OF SEDC OF COLLOID AND INTERFACE CHEMISTRY

Shandong University

实验室主任: 杨孔章 教授

学术委员会主任: 杨孔章 教授

实验室主要研究方向:

1.界面化学和有组织分子组合体;
2.分散体系;
3.超细材料;
4.表面活性剂的物理化学。

实验室主要年轻学术骨干:

穆 劲 教授
侯万国 教授
郑立强 教授

实验室通讯地址:

中国济南市山东大学
胶体与界面化学研究所
邮编:250100
电话:0531-8906961 转 2750
传真: 0531-8902167

Director of Lab:

Prof. Yang Kongzhang

Chairman of Academic Committee:

Prof. Yang Kongzhang

Main Research Fields:

1. Interface chemistry and organized molecular assemblies.
2. Dispersion systems.
3. Ultrafine particles.
4. Physical chemistry of surfactants.

Major Young Researchers:

Prof. Mu Jin
Prof. Hou Wanguo
Prof. Zheng Liqiang

Address:

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国家教委薄膜与微细技术开放研究实验室

上海交通大学

THE RESEARCH LABORATORY OF SEDC OF THIN FILM AND MICROFABRICATION TECHNOLOGY

Shanghai Jiaotong University

实验室主任: 蔡炳初 教授

学术委员会主任: 沈天慧 教授

实验室主要研究方向:

1.薄膜材料,薄膜传感器及其它薄膜器件;

2.微机械及微器件;

3.微加工技术。

实验室主要年轻学术骨干:

周 勇 教授

赵小林 教授

曾祥林 教授

实验室通讯地址:

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邮编: 200080

电话: 021-4331093

传真: 021-4333631

Director of Lab:

Prof. Cai Bingchu

Chairman of Academic Committee:

Prof. Shen Tianhui

Main Research Fields:

1.Thin film materials,its transducer and other thin film devices.

2.Micromachine and microparts.

3.Microfabrication technology.

Major Young Researchers:

Prof. Zhou Yong

Prof. Zhao Xiaolin

Prof. Zeng Xianglin

Address:

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摩擦学国家重点实验室
清华大学
STATE KEY LABORATORY OF TRIBOLOGY
Tsinghua University

实验室主任： 温诗铸 教授

学术委员会主任： 谢友柏 教授

实验室主要研究方向和内容：

润滑、摩擦、磨损。包括：润滑力学、润滑状态测量、流变学、生物润滑剂与电流变体、故障诊断与测试、铁谱技术、表面形貌测试与评价、真实表面接触分析、材料磨损及表面工程、减摩耐磨材料、摩擦化学。

实验室通讯地址：

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摩擦学国家重点实验室
邮编：100084
电话：01-2561144 转 3160
电挂：北京 1331
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Director of Lab:
Prof. Wen Shizhu

Chairman of Academic Committee:
Prof. Xie Youbai

Main Research Fields:

Lubrication, friction and wear, including lubrication mechanics, measurement of lubrication states, lubricant rheology, biological and electric rheological lubricants, failure diagnosis and measurement, ferrography technique, surface topography measurement and evaluation, contacting analysis of real surfaces, material wear and surface engineering, friction and wear resistant materials, friction chemistry.

Addresss:

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VII. APPENDIX E.

ITINERARY OF THE TEAMS

Team 1: CT Liu (team leader), Wadsworth, Dragoo (high temp materials, metals, coatings)
Beijing----Lanzchou----Hanzchou-----Shanghai----Beijing

June 17			Arrival in Beijing
June 18			Rest
June 19	09:30am		Meeting with SSTC
	02:00pm		Visit Tsinghua University
	06:30pm		Banquet
June 20	09:30am		Central Iron & Steel Institute
	04:50pm	WH 2130	Depart Beijing for Lanzchou
	07:15pm		Arrival in Lanzchou
June 21	09:30am		Visit Inst. of Chem. Phy., CAS
	01:30pm		Visit Lanzchou Univ.
	04:00pm		Visit Gansu Univ. of Tech
June 22	06:30am		Leave hotel for airport
	08:35am	WH2853	Dep Lanzhou for Hangzhou
	11:25am		Arrival in Hanzhou
	02:30pm		Visit Zhejiang University
June 23	08:05am	Train	Dep Hangzhou for Shanghai
	11:08am		Arrival in Shanghai
	02:00pm		Visit Shanghai Jiaotong University
June 24			Free time
June 25	11:05am	CA1510	Dep Shanghai for Beijing
June 26-30			Attend conference on Intermetallics
June 27	02:00 pm		Visit Inst. of Aeronautical Materials

Team 2: Barton (team leader), Thomas, Crouch** (polymer, composites)
Beijing----Chengdu----Shanghai----Hong Kong

June 17			arrival in Beijing
June 19-21			(See **Schedule in Beijing** below)
June 22	10:00am	SZ4102	Dep Beijing for Chengdu
June 23	09:30am		Visit Chengdu Univ. of Sci. & Tech.
	02:00pm		Visit NERC of Silicone
June 24			Free time
June 25	08:05am	SZ4515	Dep Chengdu for Shanghai
June 26	09:30am		Visit East China Sci. & Tech. Univ.
	02:00pm		Visit Inst. of Organic Chem., CAS

June 27	09:30am		Visit Shanghai Jiaotong Univ.
	02:00pm		Visit Shanghai Inst. of Ceramics, CAS
June 28	01:55pm	MU531	Dep Shanghai for HK

Roger Crouch's schedule in Beijing

June 20 (Tue)	8:30-10:00	Visiting the Institute of Physics
	10:20-11:30	Visiting the Institute of Zoology
	14:00-16:00	Visiting the Institute of Mechanics
	16:00-17:00	Visiting the Institute of Thermo-Physical Eng.
June 21 (Wed)	8:30-10:00	Visiting the Institute of Semiconductor
	10:30-11:30	Visiting the Institute of Biophysics
	14:00-16:00	Seminar on "Microgravity Research in USA"
	16:00-17:00	Discussions

Team 3: Schwartz (team leader), Ritchie (metals, materials, composites)
Beijing----Shenyang----Shanghai----Hong Kong

June 17			Arrival in Beijing
June 19-21			(See **Schedule in Beijing** below)
June 21	06:50pm	CJ6320	Depart Beijing for Shenyang
June 22			Visit Shenyang Inst. of Metals, CAS
June 23	09:30am		Visit Inst. of Corrosion & Metals Protection
	02:00pm		Visit North-Eastern University
June 24	02:20pm	MU5938	Dep Shenyang for Hangzhou
June 25			Free time
June 26	08:05am	Train	Dep Hangzhou for Shanghai
	11:08am		Arrival in Shanghai
	02:00pm		Visit Institute of Metallurgy
June 27	09:30am		Visit Shanghai Jiaotong University
June 28	01:55pm	MU531	Dept Shanghai for Hong Kong

Team four: Hsu (team leader), Kramer, Becker (processing, coatings, ceramics)

Beijing----Hefei----Hangzhou----Shanghai----Hong Kong

June 17			Arrive in Beijing
June 19-21			(See **Schedule in Beijing** below)
June 22	10:45am	MU5106	Depart Beijing for Hefei
June 23	09:30am		Visit Chinese Univ. of Sci. & Tech.

	02:00pm		Visit Inst. of Plasma Physics, CAS
	08:30pm	Train	Dep Hefei for Hangzhou
June 24	10:00am		Arrival in Hanzchou
June 25			Free time
June 26	09:30am		Visit Zhejiang Univ.
	03:05pm	Train	Dep Hangzhou for Shanghai
	06:21pm		Arrival in Shanghai
June 27	09:30am		Visit Shanghai Institute of Ceramics, CAS
June 28	01:55pm	MU531	Dep Shanghai for Hong Kong

SCHEDULE IN BEIJING

(The group will be separated into two teams in Beijing.)

First team:

June 19	09:30am	Meeting with SSTC (All)
	02:00pm	Visit Tsinghua Univ. (Ceramics: Hsu, Becher, Kramer, Dragoo, Thomas, Sullivan)
	06:30pm	Banquet
June 20	09:30am	Visit Inst. of Physics, CAS (Hsu, Becher, Kramer, Thomas, Barton)
	02:00pm	Visit Inst. of Aeronautical Mater. (Hsu, Becher, Kramer, Thomas, Barton, Ritchie)
June 21	09:30am	Visit Inst. of Chemistry, CAS (Barton, Thomas)
	02:000m	Visit Beijing Univ. of Chemistry (Barton, Thomas)

Second team:

June 19	09:30am	Meeting with SSTC (All)
	02:00pm	Visit Tsinghua Univ. (Metals: Schwartz, Ritchie, Wadsworth, Barton, Liu, Crouch)
	06:30pm	Banquet
June 20	09:30am	Visit Central Iron & Steel Res. Inst. (Liu, Dragoo, Wadsworth, Schwartz, Ritchie)
	02:00pm	Visit NERC of Magnetic Mater. (Schwartz)
June 21	09:30am	Visit Beijing Res. Inst. of Non-Ferrous Metals (Hsu, Ritchie, Kramer, Becher)
	02:00pm	Visit Beijing Univ. of Sci. & Tech. (Hsu, Ritchie, Kramer, Becher)

NERC - National Engineering Research Center
CAS - Chinese Academy of Sciences

Visiting Agencies

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VII. APPENDIX F.

INSTITUTIONS VISITED AND SITE VISIT REPORTS

1. SSTC, Beijing	Schwartz, Hsu, Becher, Kramer, Dragoo, Thomas, Crouch, Liu, Wadsworth, Ritchie, Barton, Sullivan
2. Tsinghua University, Beijing (ceramics)	H'su, Becher, Kramer, Dragoo, Thomas
(Metals)	Schwartz, Ritchie, Wadsworth, Liu, Crouch
3. Institute of Physics, Beijing	Crouch, Hsu, Becher, Kramer, Thomas, Barton
4. Institute of Aeronautic Mat'ls, Beijing	Liu, Dragoo, Wadsworth, Ritchie, Hsu, Becher, Kramer, Thomas, Barton
5. Central Iron & Steel Res. Inst., Beijing	Liu, Dragoo, Schwartz, Wadsworth, Ritchie
6. NERC/Magnetic Materials, Beijing	Schwartz
7. Inst. of Chemistry, CAS, Beijing	Barton, Thomas
8. Beijing Uni. of Chemical Technology	Barton, Thomas
9. Beijing Res. Inst. of Non-Ferrous Metals	Hsu, Ritchie, Becher, Kramer
10. Beijing Uni. Of Sci. & Tech.	Hsu, Ritchie, Becher, Kramer
11. Inst. Of Zoology, Beijing	Crouch (not included in this report)
12. Inst. Of Mechanics, Beijing	Crouch
13. Inst. Of Thermo-Physical Engr., Beijing	Crouch
14. Inst. Of Semi-conductors, Beijing	Crouch
15. Inst. Of Biophysics, Beijing	Crouch (not included in this report)
16. Inst. Of Chem. Physics, Lanzchou	Liu, Dragoo, Wadsworth
17. Lanzchou University	Liu, Dragoo, Wadsworth
18. Gansu Uni. Of Technology, Lanzchou	Liu, Dragoo, Wadsworth
19. Zhejiang University (metals)	Liu, Dragoo, Wadsworth
(Ceramics)	Hsu, Kramer, Bacher
20. Shanghai Inst. of Ceramics	Liu, Dragoo, Wadsworth, Hsu, Kramer, Becher
21. NERC of Silicone, Chengdu	Barton, Thomas, Crouch
22. Sichuan Union University, Chengdu	Barton, Thomas, Crouch
23. East China Sci. & Tech. Uni., Shanghai	Barton, Thomas, Crouch
24. Inst. of Organic Chemistry, Shanghai	Barton, Thomas, Crouch
25. Shanghai Jiatong University	Barton, Thomas, Crouch, Schwartz, Ritchie
26. Shenyang Inst. of Metals	Schwartz, Ritchie
27. North-East University, Shenyang	Schwartz
28. Inst. of Corrosion & Protection of Metals, Shenyang	Ritchie
29. Inst. of Metallurgy, Shanghai	Ritchie, Schwartz
30. Chinese University of Sci. & Tech., Hefei	Hsu, Kramer, Becher
31. Inst. of Plasma Physics, Hefei	Hsu, Kramer, Becher
32. HKUST, Hong Kong	Schwartz, Kramer, Thomas, Crouch, Barton, Becher, Ritchie, Hsu

State Science & Technology Commission, Beijing

Visited by: Schwartz, Hsu, Becher, Kramer, Dragoo, Thomas, Crouch, Liu, Wadsworth, Ritchie, Barton, Sullivan, (US embassy: Di Capuia, Taube)

Contacts: Shi Dinghuan, Qi Rang, Chen Zhimin, Gu Juesheng, Pan Baozhen, Qi Zongneng, Miao Hezhuo, Gan Changyan, Wang Yao, Huang Shizing, Ma Yanhe, Wang Qi'an, Xu Jing, Bian Shuguang, Ding Mingqin

On June 19, 1995, the team met with the State Science and Technology Commission (SSTC) at the SSTC building. The meeting was opened by Mr. Dinghuan Shi, the Director General of the Department of Industrial Technology at SSTC. He welcomed the delegation and expressed that he hoped to achieve four goals in this exchange. These were: 1. provide insight into the Chinese S & T efforts in materials; 2. provide feedbacks to the Chinese proposals on potential topics of cooperation; 3. pave the way for the return visit of the Chinese study team on materials; 4. set the stage for the signing of the US-China exchange protocol on materials at the 7th Meeting of the Joint Commission in March 1996.

Dr. Lyle Schwartz, the study team leader, expressed appreciation for the hospitality the Chinese had extended to the study team and expressed the hope that through these kind of exchanges, understanding and goodwill between the scientists in the materials field of the two countries would be enhanced.

Mr. Shi then traced the sequence of events leading up to this visit for the potential cooperation on materials. This was followed by the introduction of the materials R & D activities in China by Mr. Yanhe Ma, the Deputy Director of the materials Division, SSTC. This provided a broad overview of the structure of the materials research in China. Prof. Zongneng Qi who was a member of the Chinese National Advanced Materials Committee then gave an overview of the materials aspects of the high tech program, 863, in China. Mr. Shi then proposed the following schedule for the possible cooperation: June 1995, US team visited the China; September, the Chinese team would visit the US; November, drafts of the cooperative projects exchanged; Dec. 1995, cooperative projects defined; March 1996, signing of the agreement. The materials presented by the Chinese side are included in appendix D.

Dr. Lyle Schwartz then presented an overview of the materials research structure in the US, emphasizing the fact that materials research was carried out by many agencies according to their specific missions, and there were many interactions already existing between the scientists of the two countries. He welcomed the opportunity to visit China and see the various research institutions first hand. The purpose of the visit was to collect information and the team did not have decision making authority. This was understood by both sides.

An informal working lunch followed and the final logistics of the trip were worked out. SSTC informed the US team that it would send four staff members, one to accompany each teamlet as the study team fanned out to different parts of the country to visit various institutions.

Tsinghua University, Beijing 100084

Visited by: Hsu, Thomas, Dragoo, Kramer, Barton, Becher, Crouch, Liu, Ritchie, Schwartz, Wadsworth, Sullivan.

Contacts:
Prof. Li[1] Longtu, Director, State Key Lab. of New Ceramics & Fine Processing
Prof. Tian Jie-mo, Director, Beijing Fine Ceramics Lab.
Prof. Huang Yong, Head, Materials Science & Engineering Department
Prof. Miao Hezhuo, Materials Science & Engineering Department
Prof. Hong-Sheng Fang, Materials Science Department
Prof. Zhou Xiao, Acting Director of the Institute of Polymer Science
Prof. Gu Yuqin, Engineering Mechanics Department
Prof. Zhou Qixiang, Deputy Director, Research Institute of Materials Science

Description of the Institute: Tsinghua University is the leading science and engineering university in China; in fact it is generally regarded as the MIT of China. It consists of 5 schools, 28 departments, 35 research institutes, 144 laboratories, 11 factories and 22 companies, with an enrollment of approximately 14,400; this includes 3,900 faculty, 11,000 undergraduates and 3,000 graduate students. The university has numerous centers of excellence and has led many of the materials research and development efforts in China. Its alumni are now in many key government positions as well as in many prime research and teaching positions throughout China.

Materials research at the University is being conducted in several departments. The visit of the study team therefore was subdivided into two groups: one on ceramics and one on metals.

Ceramics

Visited by: Hsu, Thomas, Dragoo, Kramer, Becher, Sullivan.

Introduction: Ceramics research at Tsinghua has two parts, the State Key Laboratory of New Ceramics and Fine Processing and the Materials Science & Engineering Department. The State Key Laboratory is housed in the suburban Tsinghua campus away from the main campus as a part of the nuclear facility and functions primarily as a research laboratory with post-graduate students without classroom teaching duties. The part in the Materials Science & Engineering Department has both the undergraduate and graduate teaching and research functions.

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[1] All Chinese names in this report follow this sequence: Surname, given name

State Key Laboratory of New Ceramics and Fine Processing

Activities and assessment: The R&D activities at the State Key Lab. focus on ceramic powder synthesis and processing related to both hi-tech ceramics (e.g., orthopedic implants, cutting tools, wear components) and piezoelectric and ferroelectric ceramics. The research activities include the development of microstructural design approaches for toughening and strengthening ceramics via modeling and experiments. No details in this area are given, but it appears that much of their efforts on modeling, as well as on the development of advanced ceramics, rely on literature findings.

The State Key Lab.'s R&D level is geared to developing ceramics for the internal market and is comparable to many ceramics research labs outside China with a noted exception: the availability of small production scale equipment and instrumentation. Because of the need to produce parts and products to generate income, the lab. has equipment from bench scale all the way to production facilities. This is unique to China at this point in time. If properly used, many research activities can be vertically integrated taking concepts to large scale demonstration. On the other hand, the need to produce products to generate income could become the dominant activity and basic research would suffer, forfeiting this unique advantage. Throughout the visit in China, this point is repeatedly observed.

Facilities: Ceramic powder synthesis focuses on D. C. plasma methods for non-oxides and co-precipitation for oxides. Their co-precipitation facilities include those with output capacity of ~ 30 tons per year apparently employed for zirconia and alumina powder production. However information was not available as to the quality (e.g., purity, particle size distribution). Other facilities are under construction for powder processing and densification on small pilot-scale level. Much of the facilities are quite conventional; in fact, they tend to be aimed at very low cost/low tech processing and/or older facilities. The low cost/low tech aspect appears to be an emphasis of their attempts to enter the Chinese market place. They have produced ceramics for orthopedic implants and replacement components. Efforts are underway in the production of silicon nitride ceramics and transition of these materials for the cutting tool and wear component markets. Similar efforts in developing silicon nitrides for similar markets are underway at several institutes and universities in China.

Overall, the large scale synthesis and production facility for normal and nano-sized ceramic powders and the fabrication facilities for low cost/low tech manufacturing of ceramics might be of interest for cooperative research. However, one would want to be informed of their current progress in the operation of the new facilities and details of the characteristics of the powders and materials produced.

Materials Science and Engineering Department

Activities and assessment: The department conducts research on the mechanical behavior of ceramics with testing facilities for measuring creep under tension or compression in air up to 1400°C. Facilities and research are also conducted on fracture strengths, toughness, and R-curve behavior of ceramics. The researchers also claim to be developing microstructural design concepts; but no details were given. There is a reasonably well-equipped lab devoted to the measurement of piezoelectric properties, and this group has been active in developing what appear to be novel devices based on materials they have developed. The mechanical properties research is comparable to many western laboratories; there may be real potential in collaborations with the group working on piezoelectric and ferroelectric materials. This group is currently collaborating with Prof. Newnham at the Pennsylvania State University.

The department has a strong ceramic processing research effort headed by Prof. Miao Hezhuo who is also in charge of a small production facility for producing silicon nitride cutting tool inserts starting from powder processing and carrying through shaping and finishing of the tools themselves. These cutting tools are currently being sold within China for metal-working. As an university enterprise, this activity has been hailed as a success story. The production cost is sufficiently low that the market develops rapidly. Last year they sold 100,000 pieces of silicon nitride inserts. One should note that in this kind of set up, the cost of production is often "subsidized" by the institution in terms of space, utility, and student labor.

Metals and Polymers

Visited by: Crouch, Liu, Ritchie, Schwartz, Barton, Wadsworth.

Activities and Assessment: The visit primarily involved viewing the research and laboratories of Professor Hong-Sheng Fang of the Materials Science Department, Professor Zhou Xiao, the Acting Director of the Institute of Polymer Science, and Professor Gu Yuqin of the Engineering Mechanics Department. In addition, we met Professor Zhou Qixiang, the Deputy Director of the Research Institute of Materials Science. By reputation and based on previous visits by some of the Study Team members, the overall quality of the personnel and science at Tsinghua is generally regarded as stellar. However, the Study Team on metals and polymers was somewhat disappointed by what we saw during this visit. Possibly because we did not meet the right people or did not see the right Departments, but the general appearance of the laboratories, the general state of the equipment that we saw, and in fact the general nature of the research that was presented to us was not of the very highest standard that we expected. Several of the Study team had expected to meet specific well known researchers at Tsinghua, but they were either unavailable or not informed of our visit.

Specifically, we were introduced to the work of Zhou Xiao on polymer blends and liquid crystals, which involved some recent collaborations with Dupont in the U.S. In addition, we were shown the fundamental studies of Hong-Sheng Fang on the bainite reaction in steels. We were told that the latter work is extremely highly regarded in the international community and supposedly supports the renegade theories of Hub Aaronson at Carnegie Mellon University in the U.S.; however, we found it to be somewhat pedestrian. Scanning tunneling microscopy was being utilized to examine sub- and sub-sub-microstructural "units", which is commendable, but apart from "experts" such as Aaronson, we would not expect that this work would generate too much excitement in the States.

In the Engineering Mechanics Department, we saw Gu Yuqin's thermal physics research on thermal wave measurements and calculations. Her laboratory was immaculate and had up-to-date equipment for experiment and modeling. We got the sense of a competitive effort with very bright undergraduate and graduate students busily working on many current projects. In fact, she is a participant in the recent round-robin on thermal conductivity in diamond films run by NIST and will participate in the diamond conference at NIST in August 1995.

However, we did not meet one of the major materials efforts in the Engineering Mechanics Department at Tsinghua, that of Professor Hwang Keh-Chih. (His former student, Qing-Ping Sun, is also a Professor in this Department, but is currently working at the Hong Kong University of Science and Technology). The fundamental work of Hwang and in particular Sun on the numerical and applied mechanics of phase transformations is world class, arguably the best in the world; many researchers at major institutions in the U.S. (e.g., Harvard, Berkeley, UCSB) are well aware of their work of the modeling of transformation toughening in ceramics and currently interact with them at various levels.

Facilities: Tsinghua University is known to be very well equipped, even by U.S. standards. In previous visits, many of the Study Team had been shown extensive facilities, particularly involving mechanical testing, electron microscopy, and spectroscopy. However, in the current visit, we did not see any of this, and most of the equipment that we did see appeared to be old and antiquated. The exception to this was Gu Yuqin's laboratory in Engineering Mechanics, which contained modern equipment for thermal wave measurements.

Proposals

- The Studies on Microstructural Design of Advanced Ceramic Materials and their Tribological Properties
- The Synthesis, Preparation, and Property Evaluations and Development of New Ceramics
- Nanoceramic composites and Bio-active Functional Ceramics
- High Performance Relaxor Ferroelectric Ceramics for Smart Actuators
- Development of New Type of Piezoceramics-Electrorheological Combined Stepper Motors
- Design and Development of High-Temperature Smart Ceramic Composites
- The Crystallization of Glass Ceramics Induced by Electric Field and Current Pulses
- The Study of Ion Implantation in Ceramics:
  A.) Diffusion Behavior Study of Ag Implantation in SiC Single Crystals
  B.) Optical Property of Nanometer Particles Distributed in Implanted Layers of Ceramics
- Biomimetic Synthesis of Bone and other Implant Materials
- Superplastic Deformation of Materials with Non-ideal Microstructures and the Problem of Superplastic Mesoscopic Deformation
- Synthesis of Multilayer Film-Ceramics Composite Materials
- New Type of Graphite Material Used in Environment Pollution Control
- Investigation of Metal/Ceramic Micro-assembled Coatings
- Control of Gradient Morphology of Polymer Blends and their Surface Properties
- Reactivity of Functional Group Monomer in Non-Equilibrium Copolycondensation
- Thermotropic Liquid Crystalline Block Copolymers used as Compatibilizers in insitu composite

Recommendations: In general, the level of research at Tsinghua University is of very high caliber, and the personnel are among the very best in China. As noted above, the Study Team was somewhat disappointed by what it saw but felt that since it merely received a "snap shot" of this research, therefor some of the conclusions reached here may be biased.

In the area of ceramics, we feel we should obtain input from Prof. Newnham in Pennsylvania State University on potential interactions on piezoelectric/ferroelectric research efforts. We did not receive much information on how the experimental studies on the development of advanced ceramics and their reported theoretical modeling studies interface. This is of great interest to us. Microstructural design for tribological applications would be of interest to researchers and industry alike. The bio-active ceramics need to be monitored, if they turn out to have merit, the impact could be quite large. The ability to produce nanometer sized ceramic powder in large quantities would be very attractive to US researchers. Clearly this is a need to make a more inclusive in depth assessment in this institutions.

In the area of metals and polymers, the work in the Engineering Mechanics Department by Hwang and colleagues on the mechanics of phase transformations certainly represents a world-class effort, and the polymer studies of Zhou clearly were of merit.

From the perspective of exchange of personnel, Tsinghua is certainly one of the preferred sites for interactions. Many of its faculty are known world-wide and most international researchers who come to China have visited the university. From the prospective of fostering future and more extensive interactions, many of the programs would be of interest to researchers in the U.S.

Institute of Physics, CAS, Beijing 100080

Visited by: Hsu, Barton, Becher, Kramer, Thomas, Crouch

Contacts: Prof. Nie Yuxin, Deputy Director
Prof. Wu Xing, Prof. Ge Peiwen, Prof. Wang Wenkui, Prof. Chen Jaiqui, Prof. Mai Zhenhong, Prof. Chen Wanchun, Dr. Wang Mingxiang

Description of the Institute: The Institute of Physics is a unit of the Chinese Academy of Sciences. It's main objective is the conduct of basic research in the broad areas of condensed matter physics, optical physics, atomic and molecular physics, plasma physics and theoretical physics. It is comprised of 34 research groups, including three State Key Laboratories, and employs 536 scientific and technical personnel, 171 graduate students and 25 postdocs. There is no undergraduate program. The Institute produced 870 scientific papers in 1994, 357 of which were published in international journals. It is said to rank as the foremost research institute in China with respect to the international exposure of research results.

Approximately 40% of funding is provided by the Chinese Academy of Sciences, with the remainder obtained from research contracts and other external sources. Since 1987, the research projects underway have been reviewed on a three year cycle by a committee of experts, with decisions made with regard to project terminations and new starts. Approximately 10% of ongoing projects are terminated upon review.

Two separate visits to the institute were conducted, one by Dr. Roger Crouch representing NASA visiting the materials in space activity, one by the group visiting the general materials research.

Activities and Assessment: *Materials in Space*

The visit to the materials science in space group of the IP was hosted by Prof. Peiwen Ge. The senior official representing the IP was Prof. Nie Yuxin who is the Deputy Director. Prof. Ge is responsible for the furnaces for the Chinese space experiments related to directional solidification, including those which are developed by the Institute of Semiconductors. Others in the group included Prof. Wenkui Wang who has worked with Prof. Spaepen of Harvard, Prof. Jaiqui Chen who is constructing a 20 m drop tube, Prof. Zhenhong Mai who characterizes surfaces and surface flows, Prof. Wanchun Chen, who does the solution crystal growth work, and Dr. Mingxiang Wang who has done work on the Russian Mir platform.

The IP group also does some characterization of materials which are run as ground truth samples to evaluate the furnaces. Characterization consists of polishing and etching and a little x-ray diffraction work. They are in the process of developing new furnaces which will be flown in the Get Away Special G432 on the Shuttle on a mission in the future. This group is knowledgeable of the US solution crystal growth program and has flown four experiments on the recoverable Chinese platform studying similar phenomena in LiIO3. One of the space experiments was not recovered due to a satellite malfunction and is still in orbit. The furnaces were quite innovative in their ability to achieve gradient control and high temperature with very little power consumption. However, they may be limited in their ability to do leading edge experiments in space because of a lack of interface control and diagnostics. Limited hardware is available but the group seemed to have adequate support for fabrication of hardware needed for the space experiments.

The major area of interest for the Chinese was their hope to sell a furnace to NASA. While that might be a possibility in the future, there was no mechanism for that to occur at this time.

General Materials Science

The research activities are varied and extensive. Of the parts we were exposed to, the emphasis appeared to be on the generation of a research capability based on the development and use of equipment designed and manufactured in China. It appeared that the effort was intended to fulfill the dual purposes of providing a low cost domestic research capability and a range of price-competitive products for export. In general, the work that we saw was average in terms of creativity and innovativeness. It generally followed the well-established research direction with the apparent aim of equaling and then exceeding the properties of materials first produced elsewhere. The exception was the capability in crystal growth, which was first rate.

We were shown a four target magnetron sputtering rig that was designed at the Institute of Physics and was being produced by a Chinese company in quantities estimated by researchers to be ten units per year. This unit was being used to produce giant magnetostrictive magnetic multilayer materials (Fe/Mg and Fe/Ag), with magnetic properties that have been published in the international literature and are claimed to be the best in the world.

We also saw an excimer laser ablation MBE apparatus that was newly delivered and not yet operational that was a prototype of a possible commercial product. The equipment used a German laser but was otherwise of Chinese manufacture. An earlier model of the machine was said to have produces high temperature superconducting thin films with critical current density of 3,000,000 amperes per square centimeter at 90 K.

Both of the preceding facilities were near, if not quite at, the state-of-the-art and represented excellent value for the estimated purchase cost to outside users.

A particular strength of the Institute is in the growth of non-linear crystals. Approximately 20 crystal growth furnace were in operation, with demonstrated capabilities to produce cerium-doped barium titanate photorefractive crystals, potassium niobate crystals for blue light lasers, terbium gallium garnet crystals for laser optical isolators and neodymium:yttrium vanadate solid state laser crystals. A large number of crystal growth methods were in use, including a floating zone, halogen-heated unit with temperature capability of up to 2800 C.

Proposals:

- Preparation of High-Tc $YBa_2Cu_3O_7$ Superconducting Tapes and the Melt Textures Growth of $YBa_2Cu_3O_7$ Superconductors.
- Synthesis of New Materials (High-Tc Superconductors and Other Materials) under High Temperature and High Pressure Conditions.
- Development of New Techniques to grow New High-Tc Superconducting Thin Films on:
    A) Special Substrates or Tapes Through Buffer Layers
    B) Ferroelectric Materials.
- Crystal Growth and Laser Properties of Rare-earth Orthovanadates.
- Improvements of Photorefractive $BaTiO_3$ Crystals and Development of New Materials.
- Development of New Photorefractive Semi-insulating Multiple Quantum Wells Materials, Devices, and Applications.
- Multi-zone Furnace with Computer Controlled Power Distribution.
- Research on Materials Science in Space Including: Metastable Alloy under Microgravity, Compound Eutectic Growth of Metals, Crystal Growth in Space, and Applied Space Materials Application Development.

Recommendations: In the space materials area, they proposed cooperative space and ground based efforts with an exchange program for visiting scientists. A much more detailed assessment of the furnaces would be required before a decision could be made, but it is quite impressive that the furnaces which they have built are quite compact and use so little power. There may be lessons to be learned in these areas. NASA will be monitoring the capabilities and outputs of this group. The exchange of data on furnaces being developed in the US and China could be mutually beneficial. The exchange of data from space experiments through publication in the literature and through informal discussions at conferences where results are presented would also be beneficial to both sides. If the Chinese were interested, evaluation of the space grown materials using characterization capabilities at the NASA MSFC would be informative and possibly helpful to both sides.

In the general materials science area, joint work in non-linear crystals, with Institute of Physics researchers providing synthesis services to U.S. research groups strong in theory, characterization and applications would be of interest. Synthesis of new crystals is highly specialized, expensive and time-consuming, with limited U.S. capability making cooperation with Chinese researchers particularly attractive. There may also be some commercial opportunities in the marketing of low cost/moderate performance Chinese thin film synthesis equipment.

Institute of Aeronautic Materials, Beijing 100095

Visited by: Barton, Becher, Hsu, Kramer, Thomas, Ritchie visited the Institute on June 20, 1995. Liu, Dragoo, Wadsworth visited the institute on June 27, 1995.

Contacts: Prof. Wu Xue-Ren, Technical Director of the Institute
Prof. Yan Minggao, Academician, former Director, Dean of the Graduate School
Prof. Tian Shifan, in charge of superalloy development and processing
Prof. Han Yafang, Director of the Science and Technical Committee at BIAM.

Description of the Institute: The Institute of Aeronautical Materials in Beijing (BIAM) is considered to be one of the leading research and technology institutes of the Chinese Academy of Sciences; indeed it is the only materials research institute for the Chinese aviation industry and is recognized as the Materials R&D Center of the Aviation Industries of China (AVIC). Directed by Professor Wu Xue-ren, who is quite well known in the international metal fatigue community, it consists of 22 laboratories, including the National Key Laboratory for Advanced Composites, 2 workshops, 13 small to medium scale production lines, some 20 joint-owned factories, and a Graduate School which can confer both Master's and Doctoral degrees in a number of academic disciplines (e.g., Metallurgy, Materials Physics, Polymers, Composites, etc.). Of the total staff of 2700, 1400 are technical personnel; this includes 100 professors and senior scientists, and 400 senior engineers.

Activities and Assessment: The research activities of BIAM are centered on a wide range of materials and processes primarily for aeronautical applications, including metallic and non-metallic materials, hot processing, physical/chemical inspection, and microstructural characterization. Under the leadership of their former director, Academician Professor Yan Minggao, their research activities became particularly well recognized internationally in the area of fatigue fracture, a feature which the current director Professor Wu has maintained. However, while BIAM's focus is principally devoted to its materials R&D programs, it is also in the business of commercializing new alloys, processes and products which have been developed at the Institute. The revenue from such endeavors is claimed to provide more than 50% of the funding to the Institute, and notably includes such products as a new Hf-free directionally-solidified turbine blade alloy (see below), brakes for civil aircraft, titanium alloy golf clubs, graphite composites for bicycles, and Ti-Co alloy medical prostheses.

The quality of research in this Institute was quite high. In particular, their work on fatigue, fracture and fracture mechanics, headed by Profs. Yan and Wu, is especially well known, and encompasses both experimental and numerical studies on fatigue-crack growth and small-crack behavior in aircraft alloys. Over the years, both Yan and Wu have enjoyed considerable international interactions with research groups in Asia, Europe and the US; for example, Wu's recent work on small cracks has involved productive collaborations with both the Swedish Aviation Authority (FFA) in Europe and NASA (Langley) in the U.S. Other areas of note are their work on advanced titanium alloys (Yan was in fact the first researcher in China to develop titanium alloys), and in the casting of single crystal and directionally-solidified superalloys for gas turbine applications. In the latter area, they have recently produced a directionally-solidified Hf-free superalloy for blade use (called DD3), which apparently is of great interest to Pratt and Whitney. Although the high-temperature oxidation properties of this alloy are still somewhat uncertain, Pratt and Whitney was due to visit BIAM to discuss possible licensing terms.

BIAM also maintains major programs in the development of aluminum and magnesium alloys, aluminum-lithium alloys, intermetallics, and metal-matrix composites, for both airframe and engine applications. BIAM's main research appeared to be with Nb-modified α_2 (Ti_3Al) alloys, which would of less interest to the U.S. than with the γ (TiAL) compositions.

Ni_3Al alloys: BIAM has developed Ni_3Al+Mo alloys and coatings for tubing vents and blade applications and would like to interact with groups such as GE Aircraft Engines, Oak Ridge National Laboratory, and the University of Pennsylvania in the U.S. on such topics as high temperature oxidation and corrosion resistance.

Aluminum-matrix metal-matrix composites, reinforced with SiC particulate: BIAM has processed these materials by such techniques as squeeze casting for such applications as automobile pistons and a satellite camera frame. They are of interest to the U.S. but have not found a well established market here mainly because their properties have not justified by their increased cost. It is uncertain whether BIAM's alloys have superior properties or involve lower costs than their U.S. counterparts.

Rapidly-solidified (R-S) high-temperature aluminum alloys: BIAM has developed a series of Al-Fe-Si-Ti R-S alloys with excellent properties at temperatures as high as 400°C; these alloys are intended to eventually replace titanium alloys for frames and compressor parts in the cooler sections of gas-turbine engines. It was suggested that groups at Georgia Tech and the University of Virginia might have an interest in collaborating with these studies.

Fatigue and fracture mechanics in conventional and advanced material: BIAM's work on these topics, in particular on the properties of small cracks, is of high standard. Many groups at universities and national laboratories, such as NASA Langley and at Berkeley, would probably benefit from such interactions.

Facilities: We did not have time to see much of BIAM's equipment, however of the facilities we saw, they are very good. For example, in the fatigue and fracture area, they possessed numerous modern servo-hydraulic testing machines (e.g., MTS's), and corresponding crack monitoring equipment. Although we did not actually see them, their facilities for the manufacture and processing of materials also looked to be of high standard, at least that is the impression that one gets from their description in the handouts.

Proposals:

- Development and Application of Ti-Al Based Alloys, Relationship Between Composition, Process, Microstructure, and Properties of These Alloys.
- Development of Oxidation and Corrosion Resistant Ni_3Al Based Alloys.
- High Performance and High Volume Fraction Ceramic Particulate Reinforced Aluminum MMCS.
- Rapid-solidification High Temperature Aluminum Alloys: Deformation Mechanisms & New Alloy Development.
- Particulate-reinforced MMC by Spray Atomization and Co-deposition.
- High Temperature Polyimide Composites: Improve High Temp. Properties and Processibility.
- Research on Cure Monitoring Techniques of Polymer Composites.
- Nanostructured Intermetallics: Powder Synthesis by Mechanical Alloying & Material Formation.

Recommendations: Clearly the strengths of BIAM lie in the processing and mechanical-property characterization of airframe and engine alloys for aerospace use. From a fundamental perspective, their numerical and experimental work on the fatigue and fracture of conventional and advanced materials is of high standard, and useful collaborations, such as with the groups at NASA Langley and the Lawrence Berkeley National Laboratory, could be productive.

With respect to material development for industrial applications, their research on airframe materials (aluminum and titanium intermetallic alloys) is good and collaboration with DOE Oak Ridge Laboratory probably would be mutually beneficial. In the processing of superalloy and intermetallic engine materials, their work with innovative cast and wrought technologies appears to be quite advanced and would be of interest to many engine companies in the U.S. (as evidenced by Pratt and Whitney's interest in their DD3 alloy).

This Institute is clearly a prime site for possible interactions and collaborations with the U.S., both from the perspective of fundamental research with universities and national laboratories and possible joint ventures with U.S. industry into the use of BIAM processed superalloy engine alloys.

Central Iron & Steel Research Institute (CISRI)

Visited by: Liu, Dragoo, Wadsworth, Schwartz, Ritchie

Contacts: Prof. Yang Chusen, Vice President of the Institute
Prof. Zhu Jinghan, Deputy Director, contact person for collaborations

Description of the Institute: The Institute was established in 1952 and is a comprehensive scientific research organization. The Institute performs research and development, commercializes research results, and engages in manufacturing engineering. It is directly under the Ministry of Metallurgical Industry. At present, its research includes iron and steel but also emphasizes new materials, including superalloys, refractory metals, refractory materials, magnetic alloys, intermetallics, and ceramics. CISRI employs a total of 3,200 people, of which 2,000 are technical professionals. The Institute contains three major research divisions: Iron and Steel Technology, New Materials Development, and Testing and Analysis Technology. Eight departments report to the New Materials Development Division: 1) Precision Alloys; 2) Refractory Metals; 3) Superalloys; 4) Alloy Steels; 5) Power Metallurgy; 6) Surface Technology and Metal Corrosion; 7) Welding; 8) Functional Materials.

Activities and Assessment: The research projects at CISRI are supported by national needs (50%), Ministry requirements (12%), industrial support (15%), and institute initiatives (10%). The Institute is actively participating in technology transfer and joint ventures with Chinese industries. We were surprised to learn that only 20% of its financial support comes from government agencies, with 80% from its revenue from industrial operations. The Institute is also active in international exchange programs and cooperative projects. At present, for example, it has developed scientific, technical, and economic cooperation with a number of foreign countries, including Australia, Ukraine, Russia, Switzerland, and the U.S. CISRI has also established collaborative research projects with U.S. companies such as the Lincoln Company and LTV.

The Institute invited the delegation to tour the CISRI exhibition room, in which research projects and materials fabricated by the institute were displayed. New materials and products developed at the Institute include $Nd_2Fe_{14}B$ permanent magnets, Mo and W alloy hardware, hydrogen storage materials, turbocharger rotors, power products, Ni_3Al alloys, shape-memory materials, and corrosion resistance alloys. We were very impressed with both the breadth and the depth of the research and the quality of the work conducted at CISRI. In order to collect corrosion data of Fe-base alloys in air and soil, the Institute has set up several corrosion laboratories at different locations in China. Through discussions, we realized that CISRI is heavily involved in R&D of $Nd_2Fe_{14}B$ materials processed by rapid solidification.

We spent considerable time discussing possible ways for technical cooperation. Both parties appear to agree that bilateral cooperation can be pursued in three modes: (1) technical service, (2) technical collaboration, and (3) exchange of technical personnel and graduate students. It was generally agreed that intellectual properties and patent rights emerging from such collaborations should be shared by both parties. CISRI is interested in the establishment of joint ventures with U.S. companies.

Proposals: The U.S. delegation received a total of 8 brief proposals:

- Development of Magnetic Components.
- Research on Hydrogen Storage Materials with High Capacity, Fast Activation and Long Cycle Life for Electric Vehicles.
- Grain Boundary Segregation of Sn in Fe-Si Alloys and Its Influences on the Texture and the Normal Grain Growth.
- Co-continuous Nickel Aluminide-ceramic Composite.
- Fabrication and Evaluation of SOS-6 SiC Reinforced High Density Ti_3Al Intermetallic-based Composites.
- Investigation on Functionally Gradient Ceramic Film Coated by Self-propagation High Temperature Synthesis (SHS).
- R&D on Low Activation Oxide Dispersion Strengthened (ODS) Ferritic Alloys for Commercial Fast Breeder Reactor (FBR) and Fusion Reaction Applications.
- Studies on Microstructure Properties and Application Development of Some Advanced Ceramic

Matrix Composites.

Recommendations: Because of time limitations, these proposals were only briefly discussed. CISRI is very enthusiastic about cooperation with U.S. institutes and industries. The proposals are generally of good quality for cooperative studies. The U.S. delegates suggested additional topics and contact persons for possible U.S./China cooperation. One topic suggested was to improve the fracture toughness and to develop processing/microstructure/property relationships for $Nd_2Fe_{14}B$ permanent magnets. We were surprised to learn that CISRI is very active in technology transfer of ductile Ni_3Al alloys to Chinese industries. At present, CISRI produces 5-10 tons per year of Ni_3Al for industrial use, including fabrication of parts for jet engines. Overall we were impressed with the breadth and depth of the R&D at CISRI and with the extent of the participation in and understanding of collaboration with the US.

NERC/Magnetic Materials, Beijing

Visited by: Schwartz

Contacts: Prof. Rao Qilin, Vice President
Prof. Ding Yimin, Director, Center of Magnetic Materials

Description of Institute: Beijing General Research Institute of Mining and Metallurgy (BGRIMM) was founded in 1956 under the Ministry of Metallurgical Industry. It is a research and design institution for mineral processing. During the 1960's it expanded into a comprehensive research organization involving mining, mineral processing, nonferrous metallurgy and engineering materials. Since 1983, it has been shifted under China National Nonferrous Metals Industry Corporation, a wholly owned government industry. The institute has 1,600 employees with 900 professionals. It has 48 professors and 140 associated staff with graduate degrees. It also trains graduate students in the area of mining and mineral processing.

Activities and Assessment: The Institute conducts comprehensive research into development of mineral resources of nonferrous, ferrous, rare and noble metals and non-metallic minerals. Many of the research activities are in the mining and mineral processing areas. It is well equipped including pilot plant sized equipment (60 kg/hour ore throughput equipment). They claimed that they could provide packaged services from research to turnkey projects in mining and mineral processing.

The laboratory houses the State R&D Key Center of Magnetic Materials. In this area as in all others, they are really operating a business from R&D to manufacture and sales, by themselves, with other companies in China, and through International joint ventures. As I was leaving I met a visitor from Australia who is living in Beijing while he sets up this joint manufacturing venture (and learning Chinese in the evenings). This Institute like so many others in China has completely reinvented itself in the ten years since the new government policy. They are a money-making concern, but, of course, have little or no long term research. It is an engineering and production concern, and as best as one can judge on such a short visit, a very good one.

The magnetics work is all focused on making product, not on understanding, and the presumed first user of the product is the mining industry. Other applications are sought and welcomed, but they do not drive the research agenda. Their building dates only from 1992, and equipment is modern. They have 40% of the ferrite market in China and similar large market shares in other materials.

Proposals:

- Anisotropic Compounded Materials of Rubber (or resin) and Hard Ferrite with High magnetic properties.
- Research on the Th_2Fe_{17} type 2:19 monoclinic permanent magnetic phase in Sm-Fe-M(Ti) alloys.
- Oriented particle deposition of Sm_2Fe_{17} film with nitrogen penetration to make anisotropic magnetic films.

Recommendations: They have a different process for NdFeB magnets (than GM), but while cleaner, the BH product is lower. The Chinese equivalent of our EPA is becoming more of a factor, and perhaps environmental technologies, especially alternate process technolog, might be a good area for cooperation. While there I also explored their involvement in Standards work, since their Analytical Chemistry lab has responsibility for all the analytical Standards work in China. They are fully plugged in to the ISO efforts and participate in relevant committees. They will use an ISO standard if one exists, but in general choose to develop their own. All standards are eventually reviewed and approved by the China State Bureau of Technical Supervision. The contact at BGRIMM for standards is Mr. Sun Ling Gao.

INSTITUTE OF CHEMISTRY, ACADEMIA SINICA, BEIJING

Visited by: Barton and Thomas

Contacts: Prof. Bai Chunli, Deputy Director, Institute of Chemistry
Prof. Fei Changpei, Director, Division of Science and Technology
Prof. Xu Mao, Director, Polymer Physics Laboratory
Prof. Qui Jiabai, Professor, Laboratory of Organic Information Materials
Prof. Zhang Qi-Yuan, Vice Director, State Key Lab. for Structural Chemistry of Unstable and Stable Species
Prof. Liu Yunqi

Description of the Institute: It has a total staff of 844 of which 627 are senior scientist, research associates or technical staff. There are currently 49 Ph.D. and 87 M.S. students. Prof. Y. Lee of U.C. Berkley is an honorary professor of the institute. There is a considerable emphasis on polymer science in the institute which encompasses essentially all current areas of polymer science. However the U.S. team was not able to assess to what extent each of these numerous areas was actually being pursued.

Activities and Assessment: Professor Yunqui Liu is very active in the areas of polymeric Langmuir-Blodgett (LB) films for second harmonic generation (SHG) and is publishing in refereed journals such as the Journal of Physical Chemistry. His work ranges from synthesis of conjugated polymers to construction of Schottky devices. While his work is similar to that of others around the world, the same could be said about their's relative to his. Professor Mao Xu of the Polymer Physics Lab described "MICPOR", a microporous polypropylene film. It is an open-celled film with interconnecting pores through "tortuous paths" prepared by biaxial stretching of a non-uniform nonporous crystalline film. Claimed pore size is submicron with circular pores. There is a great deal of interest in such materials today and this probably should be checked into by an American company. The team did not actually see any of this film nor did they see any specific data on separation abilities. Professor Jiabai Qui has developed non-silver photosensitive films which are already commercial. He is selling film to Lenso Physics in the USA. His diazo films are now being sold by the Japanese he said. Professor Kong, Fanao is working in molecular beam reaction dynamics. His work is similar to that of Y. Lee and Cheuk Ng in the U.S. Iran Thomas (DOE) expressed interest in his research on soot formation mechanisms. No details of this work were made available but this did not seem to diminish Dr. Thomas' enthusiasm. The quality of work here appeared to be excellent. The team was not shown any facilities but the work described most definitely required instrumentation well above average.

Collaborations: There is an existing collaboration with DuPont on polymers synthesized by ICAS and evaluated by DuPont. There is also a project with DuPont on the thermochemistry of some polymers, however the details of this project were unclear. ICAS has two funded projects by Ford Motor Co. ICAS had a collaboration with Western Petroleum Corp. in which they synthesized some silicon compounds presumably for enhanced oil recovery. ICAS and IBM (Yorktown Heights) have just signed a contract to collaborate on projects as yet unspecified. There are "professor-to-professor" collaborations with U. of Massachusetts-Lowell and with the University of Ackron which appear to be continuations of polymer research conducted when the Chinese scientist was working in these institutions as a graduate student or postdoc.

Proposals: No written proposals were received.

Beijing University of Chemical Technology

Visited by: Barton, Thomas

Contacts: Prof. Wang Zihao, Vice President, Beijing University of Chemical Technology
Prof. Zhu Fuhua, Director, Institute of Plastic Engineering, BUCT
Prof. Zheng Chong, Director, Chemical Reaction Engineering and HIGRAVITEC
Prof. Chen Jianfeng, HIGRAVITEC
Prof. Lu Yafei, Deputy Director, Institute of Carbon Fibers & Polymer Composites
Prof. Zhang YuChuan, Polymer Science
Prof. Meng Genfa, Head, Department of Management of Technological Research
Prof. Wu Gang, Polymer Science

Description of the Institute: BUCT was founded in 1958 by the Ministry of Chemical Industry. BUCT has about 1,800 staff members including 49 professors, 250 associate professors, and 320 researchers. There are over 3,500 students. BUCT offers 18 B.S. majors, 9 majors for MS degrees, and 3 majors for Ph.D. degrees. It also has a junior college program. The Departments include Chemical Engineering, Polymer Science, Mechanical Engineering, Automation Management Engineering, Applied Chemistry, Computer and Applications, Applied Mathematics and Physics, Social Science, Foreign Languages, Physical Education. The Ph.D. programs are in Chemical Engineering, Polymer Materials, and Chemical Processing and Machinery. BUCT has 53 laboratories, 21 scientific research units. BUCT owns a Chemical Machinery Plant, a Fine Chemicals Plant and a Polymer Processing Plant.

The most important area for the study team was the Department of Polymer Science and Research Institute of Polymer Materials. This Department has about 600 undergraduates, 120 MS students, and 40 Ph.D. students. So far it has trained over 3,000 students with B.S. degrees and 140 with MS and Ph.D. degrees. The Department offers 15 courses of study including Polymer Chemistry, Polymer Physics, Polymer Materials, Polymer Processing, Polymer Crosslinking and Ageing, Mold and Product Design, Elastomer Chemical Modification, Principles and Methods of Rubber Formulation, Polymer Reaction Engineering, and Polymer Engineering Design. The research activities include work in polymerization, structure and property relationships, functional polymers, synthesis of polymers, carbon fibre and the high strength and high modules polymers and composites.

Activities and Assessment: Professor Zheng Chong described work in high gravity processing. This involved the use of a centrifuge to make fine metal oxide particles. They showed a calcium carbonate powder. They were developing separation and extraction processes. They have collaborated with Case Western Reserve University and said that they were interested in selling fine particles or having US visiting scientists. We were not shown any of the facilities. The centrifuge work may be of interest.

Proposals: Only topics were given, no details were available

- Development of Pan Based Carbon Fibers: Synthesis of Acrylic Copolymers and Spinning; Preparation of High Performance Carbon Fibers and Graphite Fibers.
- Development of Pitch Based Carbon Fibers: Mesophase Pitch and Spinning; High Modulus Pitch Based Carbon Fibers.
- Activated Carbon Fibers.
- Conductive Paper of Carbon Fibers.
- Sizing Agent and Oil for Carbon Fibers.
- Application of Short Carbon Fibers Reinforced Thermoplastics.
- RTM Technology and Products.
- Thin Walled Composite Products.
- Synthesis of Engineering Plastics.
- Inorganic/organic Fillers Filled Thermoplastics.
- Interphase of Polymer Composites.

Recommendations: This may be a good institute for industries to do contract research.

Beijing Research Institute of Non-Ferrous Metals

Visited by: Hsu, Ritchie, Becher, Kramer

Contacts: Prof. Wang Dianzuo, Institute President
Prof. Qin Shuncheng, Director, Rare Earth Research Institute
Prof. Gan Changyan, Vice Director, Powder Metallurgy & Special Materials Dept.
Prof. Zhan Feng, Powder Metallurgy & Special Materials Dept.
Mr. You Zhongyuan, Vice Director, R & D administration Office
Mr. Yu Qiang, Assistant to the President
Mr. Zhu Xiaodong, Deputy Director, Foreign Affairs Department
Ms. Xiao Fang, Foreign Affairs Department

Description of the Institute: The Institute was founded in Nov. 1952 and is the largest research center for nonferrous metals in China. The president, Prof. Wang Dianzuo is a member of the Chinese Academy of Sciences and a Foreign Associate of the National Academy of Engineering of the United States. Major materials directions are in non-ferrous metals minerals processing, new materials development including ceramics, superconducting materials, powder metallurgy, aluminum alloys, semiconductor materials, rare earth materials-synthesis and chemistry, metal matrix composites (MMC), materials characterization, and process automation and computer control. There are four national centers in the Institute: the National Center of Analysis & Testing for Nonferrous Metals and Electronic Materials, the National Center of Quality Supervision & Testing for Nonferrous Metals and Electronic Materials, the National Research Center for Semiconductor Materials Engineering, the National Research Center for Metal Matrix Composite Engineering & Technology. It has 1,400 researchers and engineers and ranks among the top materials research centers in China. The institute confers both M. S. and Ph. D. degrees in the areas of materials chemistry, metallurgy, and mineral processing. It is one of the key research centers for rare earth chemistry in China. It exports about $300, 000 to $500,000 rare earth minerals and powders every year. Of the total annual budget of 2 billion yuan, about 50 % are derived from the "enterprises".

Activities and Assessment: The institute conducts a wide range of materials R&D with pilot plant and manufacturing facilities for many of the "products" that are outgrowths of their research. Joint ventures with foreign companies have resulted in marketing efforts in the America, Europe, and Asia. It has extensive knowledge of rare earth metallurgy and synthesis of rare earth compounds combined with business activities in supply and sales of rare earth materials world-wide. The activities of the Rare Earth Research Institute involves research on mineral extraction, separation, purification, and applications. They have developed rare earth material applications in florescence, electric light sources, hydrogen storage, hydrogen storage electrode, magnet, and automotive exhaust catalysts. In fact, they claimed that addition of a trace amount of rare earth elements in fertilizers had substantially increase the yield of crops. A product list of rare earth elements, upon team member's request, was supplied to the team.

The activities in semiconductor materials have resulted in the development of facilities for production of large-scale silicon crystals with characteristics comparable to world standards at lower cost. As a result, the institute has successfully entered the international market for silicon substrate.

Presumably this provides leverage for their research activities and for the acquisition of research equipment. Excellent capabilities in rare earth and silicon growth technologies. No tour was made of the research facilities due to time constraints, and judging from the brochures, this institute is well-equipped with modern instrumentations.

Proposals

- Rare Earth Chemistry and Material Design--this is a well written proposal involving phase diagrams, theoretical calculations, and application research in various product areas.
- Study of Manufacture and Application on Discontinuous Fiber Reinforced Metal Matrix Composites.
- Aluminum Nitride Metallization in Microelectronics: Cu-AlN Direct Bonding by Active Element Thin Film.
- The Development and Manufacture of Mh/Ni Battery for Electric Vehicles.
- A Study on Silicon Nitride Strengthened and Toughened by Dispersing Particulates.
- A Study on the Compaction and Characterization of Nanophase Materials (metals).

Recommendations: An obvious resource for expertise in the chemistry of rare earth materials and in their synthesis. They have interest in collaborations in the development of MMCS. MMC's have been extensively studied in the U.S. but have had very limited application. It is not clear that the institute has approaches offering significant advances or advantages.

On the subject of rare earth chemistry, this is a topic that the study team is very interested in. One aspect of this is that rare earth oxides (REO) are most frequently employed as additives to silicon nitride powders to facilitate densification. Studies elsewhere show that changing the REO (and possibly their purity level) used effects not only the densification but also the microstructure and toughening behavior. With their expertise in rare earth chemistry and processing, we strongly recommend that some form of collaboration be established with the institute on understanding the role of REO on the densification and mechanical behavior of silicon nitride and carbide ceramics. Exchange of materials and information, in particular on rare earth oxides would be very useful if the institute could supply small quantities of very high purity REO powders for collaborative studies with U. S. researchers studying processing and behavior of silicon nitride and carbide ceramics. In return, U.S. researchers could provide them greater access on the modeling involved in microstructural design modeling and its application to ceramics.

Beijing University of Science and Technology

Visited by: Hsu, Ritchie, Becher, Kramer

Contacts: Prof. Sun Zuqing, Vice President, Dean of Graduate School, Beijing University of Science and Technology
Prof. Ziao Jimei, Academician, Director, Materials Failure Research Institute
Prof. Mao Weimin, Head, Materials Science and Engineering Department
Prof. Zhu Fengwu, Head, Materials Physics Department

Prof. Lu Fanxiu, Head, Division of Thin Film Technology
Prof. Chu Wuyang, Department of Materials Physics
Prof. Chen Guoliang, Director, State Key Lab for Advanced Metallic Materials
Prof. Hu Maopu, Director, International Affairs

Description of the Institute: The Beijing University of Science and Technology was founded in 1952. It is a comprehensive institution covering the fields of engineering, science, management and the humanities, with a particular focus in materials science and metallurgical engineering, containing 6 of the 12 State Key Laboratories in the fields of materials science and engineering in China. The University encompasses 18 faculties/departments, with 3,560 staff, including 1,471 faculty and 128 senior research staff. Total enrollment is 9,260, with 1,437 full time graduate students and 4,301 full time undergraduates, with the remainder evening and part time students.

Activities and Assessment: The University is a technical research institute with very little emphasis on the social sciences. Materials research is conducted in many departments: Mining and Mineral Engineering, Metallurgy, Materials Science and Engineering, Metals Forming, Mechanical Engineering, Materials Physics, Physical Chemistry, Surface Science and Corrosion Engineering, Physics, and Chemistry. Ceramics and refractory materials are conducted in the Physical Chemistry Department. We only visited two departments: Materials Science and Engineering Department and the Materials Physics Department. These two departments conduct research in a broad range of disciplines. In the area of advanced metals and materials for structural use, the emphasis is on intermetallics, particularly 3 component aluminides and silicides, with additional work on the production of nanocrystalline metals by mechanical alloying and the development of heavy metal and superplastic titanium alloys. In non-structural applications, research is conducted on high temperature superconducting, low Curie temperature, giant magneto-caloric, super-magnetostrictive, permanent magnet, shape memory and gradient functional materials. Modeling and characterization efforts include studies of fracture, fatigue, creep stress corrosion and grain boundary embrittlement, including molecular dynamic simulations of grain boundary structure on 586-class computers involving several hundred atoms. This university is very strong in basic research and many faculty members are well known internationally. Collaborations in terms of students going abroad and continue their studies are extensive. Some of the basic research studies are of very high quality but hampered sometimes by lack of equipment and resources. One study involving in situ TEM observation of nanocrack initiation and propagation is quite ingenious.

Application-oriented research includes cooperative work with Hughes Electronics on lithium ion battery development, synthesis of high pressure cubic boron nitride crystals, and solid electrolyte gas sensors that are being tested in the steel industry. Materials processing research includes work on spray deposition, a major effort in diamond thin and thick films, and a joint venture with Hong Kong investors in NdFeB permanent magnet materials.

In the application oriented research area, the work that we saw was comparable to many western institutions. Most of the work followed well-established research areas with an apparent aim of producing materials with moderate to good properties at low cost. However, techniques for improving the adhesion of diamond thin films by excimer laser treatment of cemented tungsten carbide have been developed that are innovative and are claimed to be superior to competing methods. It is also claimed that a method has been developed for depositing adherent diamond layers on low carbon steel substrates.

We were shown only a very limited number of facilities. While most analytical equipment was purchased abroad, many experimental facilities were developed in-house at very low cost and appeared to have capabilities close to, but not equal to similar facilities in the United States. There seemed to be some emphasis on developing moderate quality, low cost production equipment from these prototypes for possible export.

Proposals

- Fundamental Research on the Development of Ultra-high Temperature Ti-Al Base Intermetallic Alloys.
- A Study on the Cyclic Deformation Process and Crack Initiation in Aluminum Single Crystals.
- Fatigue Crack Propagation of Single Crystals Having Different Crack Orientation and under Various Loading Modes.
- Simulation of Yielding and Strain Hardening Processes of Polycrystalline Specimens by Crystalline Micromechanics.
- Crystalline Micromechanical Modeling of Tensile and Cyclic Deformation in Metal Matrix Composites.
- Study on the Fatigue Process and its Characterization of Metal Matrix Composites and Bimaterials.

Recommendations: The basic research is strong and the quality of the students is high. Lack of access to state-of-the-art instrumentation for basic research hampers the level of potential achievement. This university is active in intermetallic research, and collaboration with DOE laboratories such as ORNL and LLNL would be of mutual benefit. More detailed discussions would be required to define joint research areas. Therefore personnel exchanges to define areas of mutual benefit for cooperation may be the desirable course of action at this time.

Institute of Mechanics, Beijing

Visited by: Crouch

Contacts: Prof. Hong Youshi, Deputy, Institute of Mechanics
Prof. Hu Wen-Rui, Director, Laboratory for Microgravity Science
Prof. Shu Ji-Zu.

Description of the Institute: The Institute of Mechanics is sponsored primarily by the CAS although about 75-80% of its funding is from other agencies. Its overall goal is to do basic research within areas related to theoretical and applied mechanics, with recent emphasis on the development of new technologies and establishment of new companies based on internally generated technologies. The Institute is headed by Xue Ming-lun and I was greeted by Prof. Hong Youshi, who is a deputy director.

Activities and Assessment: Within the Institute, a Laboratory for Microgravity Science has recently been established which is headed by Prof. Wen-Rui Hu. Within the new Center, there are about 24 professional employees which includes 3 professors, 4 Ph.D.'s, some post doc's , 6-10 graduate students and 4-6 technicians. They are studying fluid flows similar to Bubble Drop and Particle Unit (BDPU) experiments looking at surface tensions driven flows. They are doing flow visualization studies in half-floating zones and had recently acquired a thermal imager for studying oscillatory flows driven by surface tension. They also had a set-up for studying half-zones with various shapes and temperature gradients using tracer particles for flow visualization. The software which was being used for the analysis of the data appeared to be capable of relatively sophisticated data analysis. Another member of this group was Dr. Tao who was responsible for the design and fabrication of the cell culture flight hardware which was flown by the Institute of Zoology group.
The work in these labs was impressive in terms of the inventiveness of the researchers in fabricating experimental hardware. However, there appear to be several shortcomings to the facilities which might have significant impact on the scientific value of the results. Exposure of the fluids to the environment which could lead to contamination might be a problem for consideration. While the data acquired was interesting, its value was not easily assessable in the time allocated. The equipment available to researchers within the Center was impressive, but not extraordinary. The Center will be moving into new facilities this fall, which are just beginning construction.

Proposal: A proposal has been submitted from Prof. Hu to the recent NASA Research Announcement in Fluid Physics which has Prof. Robert Sani of University of Colorado as the US investigator. A letter from the Chinese Space Agency stating their intent to fund the Chinese portion of the experiment if selected by NASA was submitted to NASA with the proposal. Prof. Hu understands that a decision on that proposal will not be available until later in the Fall.

Recommendations: Although the work in this group is comparable to several labs in the US, it is not clear that there is a compelling case for collaboration in this area based on the existence of unique capabilities. I recommend that we continue to monitor the capabilities and results of the group and the hardware which they are developing. NASA probably is the only agency that would be interested in interacting with this group in the areas that we discussed. As far as NASA is concerned, the exchange of data about hardware being developed in the US and China could be mutually beneficial. The exchange of data from space experiments through publication in the literature and through informal discussions at conferences where results are presented would also be beneficial to both sides. The NASA Lewis Research Center, Fluids Physics Branch within the Space Experiments Division should continue to maintain contact with Prof. Hu and his group periodically.

Institute of Thermal Physical Engineering, Beijing

Visited by: Crouch

Contacts: Prof. X. Q. Zhang

Activities and Assessment: The only group visited within the ITPE is headed by Prof. X. Q. Zhang. Their goal is to study basic processes within combustion science. Recently, most of their efforts have involved the development and operation of a new 22 m drop tower. The facility is now operating and research is in the nascent stage. The two types of study currently under way are smoldering in a one gravity environment and low gravity studies of premixed gas flames. Very little was presented in terms of the work going on. The work appears to be just getting started. A video was shown of the drop facility in operation. It has only recently been completed. It was unique to this reviewer in that it used bungees to catch the payload rather than a cushioned catch. It offers a low gravity time of about 2.1 sec.

Proposals: No proposals for collaboration were discussed.

Recommendations: Although the work in this group is comparable to several labs in the US, it is not clear that there is a compelling case for collaboration in this area based on the existence of unique capabilities. I recommend that we continue to monitor the capabilities and results of the group and the hardware which they are developing. The exchange of data about hardware being developed in the US and China could be mutually beneficial. The exchange of data from experiments through publication in the literature and through informal discussions at conferences where results are presented would also be beneficial to both sides. The NASA Lewis Research Center, Combustion Science Branch within the Space Experiments Division should continue to maintain contact with Prof. Zhang and his group periodically.

Institute of Semiconductors, Beijing

Visited by: Crouch

Contacts: Prof. Lin Lanying, Academician, Vice President of the China Association for Science and Technology.
Prof. Zhong Xingru, Head, Semiconductor Research Group

Description of the Institute: The institute of Semiconductors is another CAS institute responsible for the basic research in the area of semiconductor crystal growth. The group visited is directed by Prof. Lanying Lin who is an Academician in the CAS and vice president of the China Association for Science and Technology. She is well known and respected throughout the research community.

Activities and Assessment: The Semiconductor Research group, headed by Professor Zhong Xingru consists of about 30 people. The microgravity group is a subset within that group and consists of four people. The group has flown four experiments in space, three of which have been recovered. The experiments have been severely limited by energy on a given flight and trade-offs have been made in order to accomplish growth. Other groups within the institute are working on bulk growth of other III-V materials such as GaSb, InSb and others. They utilize high pressure pullers built in China which are good up to about 30 atmospheres. The largest boule I saw was about 3 inch GaAs, which is similar to one sold to Boeing in 1989. Other research efforts in the group included infrared spectroscopy, cathodoluminescencs, photoluminescence and a dual beam ion deposition capability. They also possessed a Riber, Molecular Beam Epitaxy (MBE) which was recently bought from France. They are a key lab in semiconductor engineering, and get money from several government sources.

The work from this group is typical of a good research group doing similar work in the US. This group had a large assemblage of hardware, some with impressive capabilities but none appeared to be unique. The lack of sample preparation facilities which prevents contamination of samples may cause problems.

Proposals: While no specific proposals were offered, the group is knowledgeable of the US space program results and wish to continue current informal information exchanges.

Recommendations: I recommend that we continue to monitor the capabilities and results of the group and the hardware which they are developing. The exchange of data about hardware being developed in the US and China could be mutually beneficial. The exchange of data from space experiments through publication in the literature and through informal discussions at conferences where results are presented would also be beneficial to both sides. The NASA Marshall Space Flight Center, Microgravity Science Division should continue contact with this group periodically.

Lanzhou Institute of Chemical Physics, CAS, Lanzhou

Visited by: Liu, Dragoo, Wadsworth

Contacts: Prof. Xue Quinji, Vice President of the Institute, Director, Lab. of Solid Lubrication

Description of the Institute: Established in 1958, the Institute is one of the foremost laboratories among the 122 laboratories of the Chinese Academy of Sciences. Its research supports China's petrochemical industry which is centered in Gansu Province of which Lanzhou is the provincial capital. It also carries out research in support of China's automobile and manufacturing industry, military, aerospace program, and agriculture industry. The work of the Institute is internationally recognized. Professor Xue has been an invited lecturer at a Gordon Conference in the U.S.

The Institute employs about 700 people of which 500 are senior researchers and 84 are associate researchers who are engaged in about 200 projects. Research is being carried out in the areas of catalysis, solid lubrication, organic synthetic chemistry, analytical chemistry, and structural chemistry. The Institute has 344 pieces of advanced research equipment including 30 sophisticated pieces of precision equipment. There is a collection of nearly 100,000 books and periodicals in the library. The Institute also trains graduate students and grants degrees, 110 students having qualified for masters degrees and 11 for Ph. D. degrees since 1978. Funding is received from the Chinese Academy of Sciences (about 30%), the National Natural Science Foundation (about 20%), industry (about 30%), and various ministries. A typical project is on the order of 100,000 RMB for 3 years and will support 2 to 3 graduate students. Big projects may be on the order of 5 million RMB. About 50% of the cost (500 RMB/mo.) of a graduate student is paid by the central government; the remainder is paid by the Institute.

Activities and Assessment: The Laboratory for Solid Lubrication, LSL, established in 1987, is the largest laboratory in the Institute and employs about 70 people. LSL has research programs in surface chemistry and physics of friction, wear, and lubrication; tribology of materials with surface modifications; tribology of oils, greases, and additives; tribology of polymers and composites; tribology of ceramics; new testing equipment and research methods; and tribology applications.

The following are examples of the work carried out at LICP. Friction and wear of aluminum and aluminum alloy composites with SiC particles and fibers are being studied for metal on metal wear. Although C_{60} "Buckey balls" are not a good lubricant when used as a continuous material, LSL has found that the lubricating effect can be improved by dispersing Buckey balls on a Langmuir-Blodgett film. Surface modified MoS_2 particles have been found to have improved dispersivity in oil and improved coefficient of friction. The tribochemistry of boron-containing lubrication additives is being systematically studied to reduce friction, reduce emissions, and improve antioxidation. The important problem of improving the lubrication of aluminum alloys is being studied, but, to date, a suitable lubricant has not been found. Rare earth containing coatings on Al alloy substrate have been found to reduce friction and wear and corrosion. Isotropic sliding experiments have been conducted up to 1600°C to study the wear of Si_3N_4 under vapor phase lubrication. Friction and wear of tetragonal zirconia polycrystals (TZP) ceramics are being studied under dry sliding conditions and with water lubricant. The friction and wear of the cermets WC-Ni-Mo-PbO and WC-Ni-Co-Mo-PbO have been studied under self-lubricating conditions up to 1350°C. Surface modification by iron implantation have been serviced out with N and B implantation of steel, implantation of MoS_2 to improve surface resistance and resistance to water corrosion, and implantation of ion with Cr and Mo. Sputtered MoS_2 films are being studied to decrease the effect of water on shortening the non-use life of MoS_2 lubricated surfaces in rockets and space vehicles. Self-sustained high-temperature synthesis (SHS), or combustion synthesis, is used to produce fine TiN powders to strengthen and toughen Ni-P electrodeless coatings. Friction and wear studies are being carried out on ion-implanted polyamide (PI).

The team was shown a variety of contemporary research equipment including TGA/RI apparatus DSC, a high-temperature microscope, and an Adamuel Lhomargy (Fr) testing machine. A combination high-vacuum friction tester and surface analysis station (Phi-550) is being used to study wear under space conditions. EXAFS is being used to develop improved metal/metal-oxide catalysts and mixed oxide catalysts. EXAFS data is presently obtained in Japan. An interest was expressed in collaborating with Brookhaven National Laboratory. The Institute has a high-resolution IR instrument for off-line product analysis and an FTIR for on-line analysis. A Nicolet Raman 910 spectrometer is being used to study nanosized TiO_2. Biochemical and photochemical systems are being studied with laser Raman spectroscopy, IR/fluorescence spectroscopy, flash photolysis, and stop-flow apparatus. A recently purchased VG XPS spectrometer with a special design is being used to investigate surface reactions such as isotopic exchange reaction between CO and isotopically labeled CO on Pd surfaces. It is worth noting that these chemical analytical tools have been used to determine the compositions and molecular structures of Chinese herbal medicines.

Purchase of several pieces of equipment including the VG XPS spectrometer were made possible by a low-interest, long-term loan to China by the World Bank in 1990-91. In addition to the many pieces of commercially-made instruments, the Institute has a number of self-made instruments such as a UHV tribology tester which is coupled to the Phi-550 surface analysis station. The Institute has built a ring-on-block and block-on-ring wear tester and a pin-on-disk tester for determination of coefficient of friction.

Proposals

- The Wear and Lubrication of Ceramics.

  This is a proposal to study lubricating mechanisms of lubricants and wear mechanisms of ceramics and to develop wear models in terms of mechanics and chemistry. The collaboration would seek to optimize solid and liquid lubricants and find several ceramics suitable for high temperature applications. Ceramics to be studied would include Si_3N_4, SiC, Al_2O_3 and ZrO_2, metal oxides and rare earth compounds.

- Self-lubricating Surface Modification of Aluminum Materials.

  A collaboration is proposed to study the structure and composition of aluminum metals and their anodized films toward overcoming the poor tribological properties of aluminum-based materials. Friction and wear mechanisms will be investigated for different friction conditions. The proposed study would develop micro-embedded self-lubricating anodized aluminum through in situ synthesizing solid lubricants in the porous structures of anodized aluminum or through depositing solid lubricants by physical, chemical, and electrochemical methods.

- High Temperature Wear-resistant Alloys.

  The proposed collaboration would seek to improve the high-temperature (800°C - 1000°C) properties of Ni-based alloys strengthened with nanosized ceramic particles and to develop high temperature solid lubricants. Possible dispersion strengthened alloys and solid lubricants will be surveyed with respect to preparation, tribological properties, composition, microstructure, and tribochemistry in different environments.

Recommendations: The team found the Lanzhou Institute of Chemical Physics to be well equipped and to have a program of research on a par with U.S. institutions. Collaborations with the Institute could be highly productive and would have the possibility of yielding significant research results in the area of friction and wear of ceramics and alloys and in the development of tribological materials and properties.

Lanzhou University, Lanzhou

Visited by: Liu, Dragoo, Wadsworth

Contacts: Prof. Li Fashen, President, Lanzchou University
Prof. Wang T. M., Chairman, Department of Materials Science and Engineering

Description of the Institute: Lanzhou University is one of China's key universities and was founded in 1909. It has 22 departments, 14 institutes and 2 state key laboratories, with a total of 10,000 students (900 graduate students) and 1300 employees. The university is ranked at the top in the fields of physics, nuclear physics, chemistry, analytic chemistry and atmospheric science in China. The materials research, which has an emphasis on basic studies, has been conducted in a number of departments with funding mainly provided by the Chinese Natural Science Foundation.

The material science department is currently headed by Professor T.M. Wang and has a total of 42 faculty members and supporting personnel. The department has 4 research groups: New Materials, Ceramics, Material Physics, and Material Chemistry. There is an emphasis on physical metallurgy research in the areas of:

1) microstructures and structural defects in intermetallics (NiAl, Cu_3Au and TiA1), Shape-memory alloys (CuAlBa and CuZnAl) and perovskite-type oxides (La-Sc-Fe-O, Sm-Ca-Fe-Sr and La-Be-Fe-O systems);
2) surface modifications by iron implantation and tribological studies;
3) processing and characterization of allowys and composites (including Co_3Ti, FeAl, CuAlBe, and carbon fiber reinforced Cu-based alloys);
4) toughening of ceramics (Al_2O_3, zirconia, Si_3N_4 and Sialon);
5) studies on diamond films and diamond-like carbon films; and
6) life-cycle prediction and recycling of industrial materials.

We were impressed with the work of Lanzhou University on studies of defect structures by position annihilation and computer simulation, and processing and structural characterization of diamond and diamond-like (BN) thin films. Professor Wang is proud of his department's pioneering work on ecomaterials. Gansu Province is rich in non-ferrous minerals (Ni, Co, Pt, etc.); as a result, the university has put considerable emphasis on the studies of Ni-base superalloys and intermetallic alloys (Co_3Ti, Ni_3Al, and NiAl).

Proposals

- Studies of Superalloy and Composite Materials
- Studies on the Zirconia Transformation Toughening Ceramics and Ceria-based Electrolytes for Solid-oxide Fuel Cells
- Studies of cubic BN, Diamond and Other Thin Films
- Study and Development on the New Polymer Materials
- To Establish A Structure/property Correlation for FeAl and TiAl alloys
- To Study Interfacial Structure And Processing Of Large Size Thin Films Of Diamond And Diamond-like Materials, and
- To Characterize Fe- and Co-base Materials For Magnetic Applications.

The last three proposals were the result of mutual discussion of the potential topics and mutual interest among the visiting team

Recommendations: The people and ideas are excellent and cooperation in selected areas (such as diamond-life thin films, defects in intermetallics, and magnetic materials) would be mutually beneficial.

Gansu University of Technology, Lanzhou

Visited by: Liu, Dragoo, Wadsworth

Contacts: Prof. Chen Jian-Hong, President of Gansu University of Technology
Prof. Yi Hong, Vice President
Prof. Guang Ji Zu, Vice President
Prof. Xiao Guo Ming, Director of the Scientific and Technological Office
Prof. Ding Fan, Associate Professor
Prof. Wang Gu Zhen, Associate Professor

Description of the Institute: we met the President of Gansu University of Technology, Jian-Hong Chen, as well as his various deputies, Vice President Yi Hong, Vice President Guang Ji Zu, and Mr Guo Ming Xiao, Director of the Scientific and Technological Office. President Chen gave a very impressive overview of the university and its importance to the area and to the national needs. In summary, Gansu University is relatively new (1958), has about 5000 students (only about 100 of which are graduates), can award B.S. and M.S. degrees, and is applying for Ph.D. status. They have about 1200 faculty and staff members. The university reports to the Ministry of Machine Building and Electronics, and, as such, is intermediate between those universities that report to the State Committee of Education and those at the province level.

The location of Gansu province in China's northwest area gives it special potential importance according to President Chen. The northwest of China and the area around Lanzhou are rich in natural resources such as petroleum reserves, hydroelectric power (from the upper branch of the Yellow River), and non-ferrous ores. These include nickel (the second largest in the world with 30,000 tons annually), aluminum (300,000 tons annually), lead, zinc, cobalt, rare earth, and noble metals. There are no nuclear power stations in this province (unlike the east China provinces), and thus, the university attaches great importance to education for supporting local industry and development advanced manufacturing techniques for production and processing non-ferrous metals. For this reason, they have specialization in machine manufacture, building, and design.

President Chen described the fact that the northwest is behind the east in culture, knowledge, and information technologies, but he believes they have the future wealth of China within the northwest because of their tremendous natural resources. Although they only have limited international interactions (mainly with Japan), some of their faculty have U.S. connections; however, as yet, no graduate students have gone to the US. President Chen was very anxious to be part of future Sino-US collaborations. He has been President for 10 years and will step down in the next year or two. He plans to spend his sabbatical in the US in 1996.

The university consists of the following departments: First Department of Mechanical Engineering; Second Department of Mechanical Engineering; Department of Automatic Control; Civil Engineering; Department of Management Engineering; Department of Social Science; Research Division of Basic Science and Adult Education Center. In addition, there are four research institutes: Institute of Machine Manufacturing Energy, Institute of Welding Technique, Institute of Metal Crack Technique, Institute of Fluid Mechanics.

Activities and Assessment: Upon arrival, we toured the welding institute facilities under the guidance of Mr. Ding Fan and Dr. Wang Gu Zhen, both associate professors. The facilities were relatively old, as was some of the equipment (Rigaku X-ray unit, Hitachi SEM 562D). Their unique capability was to study the physics of the arc and the metal transfer taking place during tungsten arc welding from the electrode to the weld pool. They had a high speed camera (1,000 frames/sec) coupled to laser and x-ray back-lighted imaging systems and showed us images of such metal transfer during welding. High-speed images were correlated to electrical events during welding. The group has a collaboration with ESAB (Sweden) in welding. In adjacent laboratories we were shown state-of-the-art Fiji Electronics, Thermal Weld Simulator (similar to a Gleeble but using induction heating) and a range of basic testing equipment including an instrumented Charpy tester.

In one laboratory we were shown a powder metallurgy processing capability for producing Ni-alloy powders by a water atomization process. The powders produced by this method are currently used for surface coatings. This welding group were well represented in the open literature, having published about 20 papers in Metallurgical Transactions, Acta Metallurgica, Journal of Materials Science, and various welding journals.

Proposals

- A Proposed Cooperative Research on the Advanced Materials Project between PRC and U.S.

  This is a broad study on advanced materials and processing and covers most advanced materials issues.

- Surface Coating Materials.

  A proposal to modify surface properties for repair or protection of machine parts. Such a project could take advantage of the natural resources through the development of nickel based coatings (e.g., Ni_3Si, which is very resistant to acid attack) in collaboration with U.S. researchers.

- Development of Ni-base Brazing Materials of High Temperature.

  Ni-base brazing materials are required for brazing high-temperature alloys and stainless steels. Again, this project plays to the strength of the natural resources of Ganzu province.

- The Mass Transfer Effects of the Modified 9Cr-1.0Mo and 9Cr-1 Mo/SUS 316 Weldments under Long-term Exposed to Sodium at Elevated Temperatures.

  This project was somewhat specialized and deals with long term reliability of some welds in liquid metal fast breeder reactors.

Recommendations: The strategic importance of Gansu Province is worth noting. Its natural resources and technological focus are obviously useful leverage points. Furthermore, the university is extremely anxious to collaborate in this Sino-US venture. They have a visionary president and in their field of proposed activity have published work in top western journals. They have a notable program in welding with some international standing. There are several other young and energetic faculty; however, it was not possible to judge the quality of their research efforts.

Zhejiang University, Hangzhou

Visited by: Liu, Dragoo, Wadsworth (June 22), Hsu, Kramer, Becher (June 26)

Contacts: Prof. Tang Jinfa, University Vice President, Professor of Optical Engineering
Prof. Mao Zhi Yuan, Materials Science and Engineering Department
Prof. Wu Xijun, Deputy Director, Institute for New Materials
Prof. Ye Zhizhen, Vice Director, State Key Laboratory for Silicon Materials Science
Prof. Ding Zishang, Materials Science and Engineering Department
Prof. Qiu Jizhen, Director, International Programs Office
Dr. Chen Xiang Ming, Associate Prof., Ceramics
Dr. Kan Honghua, Materials Science and Engineering Department

Description of the Institute: Zhejiang University is one of the Key National Universities with materials science well emphasized. It is one of the oldest Universities in China, founded in 1897 as the Qiushi Academy majoring in liberal arts. The university, because of its location, has been exposed to western influence and many of its leaders were educated in the west. The university is well balanced in both humanities and engineering with 8 colleges, 24 departments offering 51 undergraduate programs, 35 doctoral programs, and 85 master programs. The faculty totals 5,046 with 14,520 students, 2612 being graduate students and 70 overseas students.

Activities and Assessment: Zhejiang University is one of the strongest materials research centers in China. The Department of Materials Science and Engineering of Zhejiang University has about 150 faculty members and offers advanced degrees in three major areas: Semiconductor Materials, Metallic Materials and Heat Treatment, and Inorganic and Nonmetallic Materials. Besides this department, the Polymer Sciences Department is well-known and is of the same size. Unfortunately our polymer experts were not able to visit this university due to travel scheduling difficulties. Because of its size and reputation, the study team visited the university twice, one by the metals team, and one by the inorganics team. This report is the combined report of the two teams.

Since Zhejiang University is a key national university, its research is well funded by the Chinese NSF, various ministries, some SSTC support, and some money from commercial enterprises. The university is designated as a key national university reporting to the Education Committee. The university has many young faculty members who had been abroad and the culture of the university is more western than many of the universities we have visited before.

The first overall objective of the materials program is to develop materials with high quality and low cost. The second objective is to engineer new materials for electronics, wear resistant alloys, glasses, ceramics, biomaterials, functional alloys, metal/glass seals. The department also carries out process research in solidification, powder metallurgy, and foundry science.

Both teams were given lab tours. In addition to excellent surface science facilities (ESCA, Auger, etc.) we were shown a silicon foundry with 8 units for the growth of single crystal Si located at the State Key laboratory of Silicon Materials Sciences. These are production units for 3 inch diameter boules of silicon that is then manufactured into wafers that are exported to Europe and the US. Apparently, they export 12 tons total per year. They grow the Si using the Czochralski method but use nitrogen instead of argon as an atmosphere which they reported reduced the amount of carbon impurity without a significant increase in nitrogen impurity level. The facility is exceptionally well equipped (and maintained) both for crystal growth and thin film deposition and materials characterization. This facility is easily on par with the better U.S. university facilities.

In the inorganics area, the visit focussed on the inorganic and nonmetallic materials research programs and centers within the Department of Materials Science and Engineering. The activities include research on advanced ceramics (e.g., silicon nitride), nano-ceramics, glasses (including oxynitride glasses pertinent to silicon nitride ceramics), ceramic joining, thin films, chemical vapor deposition processes, and mechanical behavior of ceramics. They indicated they recently procured ~ $ 150, 000 U.S. in new equipment for synthesis and processing studies and have materials characterization equipment on par with U. S. universities.

Very substantial discussions were held on their ceramics research activities which include the areas of special glasses (e.g., oxynitride glass synthesis and properties), luminescent glasses, ceramic matrix laminate composites, silicon nitride ceramics (e.g., microstructural design and processing), nano-composites, low expansion ceramics ($NaZr_2P_3O_{12}$-type compounds), powder synthesis (areo-sol synthesis of silicon nitride and carbide powders; sol-gel synthesis that avoids alkoxide precusors, hydrolysis reactions using methoxyethanol and similar precusors), liquid crystal silicon films, and toughening mechanisms in piezoelectric ceramics. Based on our observations, the ceramics research efforts at this university are quite likely the best of any university in China. The staff studying nano-composites have interactions with leading researchers in the U. S. and Europe. They appear to be developing experimental capabilities that will be comparable to those in the U.S. They are relying on the basic research finding of experts in U.S. and Europe to underpin their research at this point. They indicated that they are developing a theoretical aspect to help direct their studies in ceramics which is highly recommended to further complement their efforts. Our sense is that the Silicon materials research is already first-class.

The department has also developed business activities (3 companies) that generate more than $ 250, 000 U.S. in sales per year and accounts for ~ 50 % of the department's budget.

The efforts in ceramic powder synthesis and processing are quite strong and those in microstructural design of toughened ceramics are promising. The efforts on linking studies of the properties of the oxynitride glasses with the toughening behavior in silicon nitride ceramics can make important contributions to the advancement of such materials. The silicon materials research appears to be exceptional.

Proposals

- Research on Metal Hydride.

  Presented by Dr Qi-Dong Wang, et al. They are studying AB_5 and AB_2 (Lave's phases) compounds with an emphasis on incorporation of mischmetal (La, Nd) as a strategic use of material resources for hydrogen storage in Ni-metal hydride batteries.

- Biomaterial Research Incorporating TiNi Shape Memory Alloys.

  Presented by S.C. Wang. They are looking to remove the influence of Ni (because of its toxic potential) by growing Ti rich surface oxides and ternary alloying (such as Cu). It is worth noting the ease with which now biomaterial can be tested in humans in China by comparison with the US (No proposal attached or provided).

- A Study on the Copper-based Shape Memory Alloys.

  Presented by J.Q. Chen, et al. The main thrust is to increase the temperature range of use for Cu-base shape memory alloys (based on Cu-Zn-Mn composites).

- Fe-Mn-Al-Cr Austenite Stainless Steel.

  Presented by Cai-jin Chen. This is fully austenitic stainless steel but with no nickel and reduced Cr. The alloy has good strength and ductility at ambient and elevated temperatures. Further research is required to solve a problem of hot-cracking during welding.

- Research in Surface Engineering of Cermets.

  This work is centered on (a) TaC cermets used for particle erosion resistance, and the development of CVD coatings and (b) siliconized and carbonized wear resistant surfaces on Cu sheets at low process temperatures.

- Retreatment of Plasma Spraying Coating.

  Proposed by Mi Yang. Work in this area is focused on coating medium carbon steel substrates with Fe, Ni, and Cu based alloys for magnetohydrodynamic applications.

- A Quantitative Microstructural Analysis of Fatigue Crack Growth.

  Proposed by Jinshan Song. The work is focused on LY12 (US equivalent Al-2024) in the T4 and overaged conditions. Low frequency cyclic fatigue measurements have been carried out.

- Nanostructured Materials.

  Proposed by Wu Xijun on general basic research on nanostructured materials including powder, processing, characterization.

- A Quantitative Microstructural Analysis of Fatigue Crack Growth.

  Proposed by Song Jinshan. This project is trying to understand the effects of inclusion, dispersoid, precipitate, and grain boundary phase on the process of the fatigue crack growth.

Recommendations: Our overall impression was that the Department of Materials Science and Engineering at Zhejiang is a strong one with interesting and relevant research areas. The inorganics team members immediately sensed that interactions should be developed with this group, especially in the efforts on (1) the influence of microstructure and grain boundary phases on the toughening behavior of silicon nitride and carbide ceramics, (2) synthesis and properties of oxynitride glasses, and (3) the synthesis and processing of nano-phase ceramics. The efforts on silicon materials and on other glasses should also be of substantial interest to U. S. researchers but lie outside the general expertise of the team members. We also suggested that interactions between the researchers at this university and the group at the Beijing Research Institute of Non-Ferrous Metals who are studying processing and properties of silicon nitrides ceramics and the rare earth chemistry group might be very fruitful. Exchange should include exchange of data and materials with counterparts in U. S. studying the processing and mechanical behavior of silicon nitride and carbide ceramics; excellent potential for short term visits to conduct experiments and to develop further collaborations. In addition to ceramic materials, collaboration in the area of metallic materials, such as wear-resistant alloys, Fe-Mn-Al-Cr austenitic steels, high-temp shape memory alloys, and hydrogen materials, are of mutual interest for both countries.

Shanghai Institute of Ceramics, CAS, Shanghai

Visited by: Hsu, Becher, Kramer

Contacts: Mr. Luo Kun An, Acting Director of the Institute, currently Deputy Executive Director
Prof. Shi Erwei, Deputy Director of the Institute
Prof. Yan Dong Sheng, Academician, Honorary Director of the Institute
Prof. Guo Jing-Kun, Academician, Director, State Key Lab. of High Performance Ceramics & Super Fine Microstructure
Prof. Yin Zhiwen, Academician, Chairman of the Academic Council
Prof. Ding Chuanxian, Head, 9th Department
Prof. Sun Wei-Ying, Ceramic Phase Diagrams Research
Prof. Gao Lian, Deputy Director, State Key Lab. on Advanced Ceramics
Prof. Huang Xiaoxian, Head, 5th Department
Prof. Zhao Meiyu, Head, 4th Department

Description of the Institute: This is the premier ceramics research institute in China. It is well known internationally with extensive collaborations with many research institutions around the world already existing. Its R & D capabilities are on par, if not better, with similar institutes around the world. The institute was founded in 1928 as the Engineering Institute of National Central Academy. It has 1,075 technical staff members many of which had spent sometime abroad. It has 17 laboratories and several very successful "enterprises" selling products world wide. The institute grants academic degrees in both MS and Ph.D. for the various disciplines the institute engaged in. It is one of the most successful research institutes in China in terms of commercialization of products yet the basic research has not been weakened. The net from these sales account for about 60 % of the institute's resources for R & D, etc. and serves as an example of an uniquely successful model of the new China.

Activities and Assessment: The institute conducts research and development in single crystal growth, mechanical behavior of ceramics and composites and their relationship to microstructure, advanced processing of ceramics, nano-phase ceramics, superplastic properties, bio-materials, solid oxide fuel cell materials, ceramic coatings and processes, development of advanced oxide and non-oxide ceramics, glass technology, and phase equilibria. In general, we found the laboratories to be well equipped with modern and up-to-date instrumentation. In particular, they have many pilot plant scale facilities for semi-production research as well as batch manufacture of large sized samples for engineering component studies. Such facilities are typically absent in US research institutes.

Their expertise in phase equilibria studies, especially in silicon-based ceramics, ranks at the forefront in the world; continued and expanded collaborations with the US will be mutually beneficial. The phase equilibria data are needed by researchers working on the development and properties of silicon-based ceramics around the world. This is a unique strength.

In the area of biomaterial, the institute has been making ceramic components available for insertion over the last twenty years. Their work on biocompatible ceramic components and coatings to reinforce adhesion are backed up by retrieval studies. This kind of data is highly valuable especially in view of the stringent US FDA requirements for new materials insertion into prosthesis applications.

Their work on ceramic coatings and composites are noteworthy. Even though many of the studies are similar to the ones conducted in the US, the application experience and field test data are unique. In the US, many of the materials either due to costs, intellectual properties rights, and the fear of legal liability are never introduced into actual applications. According to researchers here, many of the research materials are routinely introduced into practice to solve a problem. This field experience is highly valuable.

The institute highly values the opportunity to cooperate with the US and they arranged the researchers to present their proposals. The presentations were very professional and the quality of the proposals are very high. Some of the proposals resulted in more detailed discussions in smaller groups. As a result, some joint proposals were developed.

Proposals

- *Advanced Structural Ceramics: engineered grain boundary phases for optimum wear resistance.
- *Phase equilibria studies in Si-based ceramics.
- Advanced Ceramic Matrix Composites.
- Compositional and Microstructural Design for High Performance Nitride Ceramics.
- Plasma Sprayed Coating Materials.

- Studies on Phase Structure Designing, Phase Transition and Application of High Temperature. Piezoelectric Ceramic Materials.
- Studies on Low Sintering Temperature Ceramic Dielectrics.
- Electrochromic Coating Materials and Devices for "Smart Windows.
- Research and Development of Solid Electrolyte, Electrode Materials and Other Key Materials. in Ceramic Fuel Cell.

* Joint proposals

***Recommendations*:** Continued interactions and support of phase equilibria studies are necessary. A means must be found to support their staffs participation in and contributions to the American Ceramic Society/NIST Phase Equilibrium Center activities. Exchange of materials and data related to processing, microstructure, and mechanical properties of silicon-based ceramics with appropriate U. S. researchers is strongly recommended. Good potential for short term exchange visits in this area as well.

CHENGDU SILICONE RESEARCH CENTER

Visited by: Barton, Crouch, Thomas

Contacts: Prof. Yue Rundong, Director
Prof. Qu Wan Xing, Senior engineer
Prof. Cai Shengquan, Senior engineer
Prof. Ma Xueming, Vice-Director

Description of the Institute: The National Research Center for Silicone Engineering Technology was Founded in 1965 and moved to Chengdu in 1987. Mission is to develop commercializable silicon product. There are 860 staff members, including 300 engineers and over 200 "senior engineers". This is more like a company than research institute since 80% of their funding is self-generated by product sales.

Activities and Assessment: The major product for their Medical Products Division is mammary implants which they claimed were for "postsurgical correction and not for beauty". They are aware of the Dow Corning's litigation problems in the U.S. Other products include silicone sealants and adhesives, chemicals for the treatment of fabrics and leathers and engineering plastics. The team was not taken to visit the actual production facilities but based on the spectrum of commercial products we were shown the facilities must be substantial and at least adequate. The institute used to have a "direct process" facility (for the production of dialkyldichlorosilanes from silicon metal) but they gave it to some Chinese company and now purchase their monomers from Torray Silicones in Japan. The team was told that Dow Corning was in the planning stage of setting up a monomer plant in Ying Kou.

Proposals and Potential Collaborations: No specific proposals for collaborations were made by this institute. They claimed to be eager to collaborate but had in mind only the exchange of personnel.

In the early 1980's they sent staff to Dow Corning in Midland, Michigan for months at a time and found this very beneficial. They invited one of the team members to come back for an extended visit to the institute.

Sichuan Union University, Chengdu

Visited by: Barton, Crouch, Thomas

Contacts: Prof. Xu Xi, Academician, Director, Polymer Research Institute and Director, State Key Laboratory of Polymer Materials Engineering
Prof. Tang Xu-Dong
Prof. Huang Rui
Prof. Wang Yeuchuan
Prof. Liu Bailing

Description of the Institute: Sichuan Union University (SUU) in Chengdu, Sichuan Province, is one of the largest and the most comprehensive University in China. It is one the Key Universities in China and ranks among the leading universities directly under that State Education Commission. Its origin can be traced back to 98 years ago, but in its present form it was formed by the merger of two key universities, Sichuan University and the Chengdu University of Science and Technology in April of 1994. The brochure of the University claims that the union of a liberal arts university and a technological university was a breakthrough because the typically liberal arts institutions were divorced from technological institutions in China. SUU has 26,000 students (1,500 in masters and doctoral programs), 4,300 faculty, 328 professors, and 1,654 associate professors. SUU claims to be the largest in China. SUU has 15 colleges and 2 research institutes, 2 national key laboratories, and 3 national specialized laboratories. SUU colleges include liberal arts, science, engineering, economics, management, law, etc. In the technical areas the Colleges include Materials Science, Engineering and Manufacturing Science and Engineering, Energy Science and Engineering, Chemistry and Chemical Engineering, Pure and Applied Mathematics, Pure and Applied Physics, Light Industry and Textile Engineering, and Life Science and Engineering.

The main attraction of SUU for the study team was the Polymer Materials Institute. The Institute was founded by the Director Xu Xi in 1964. Professor Xu Xi received an MS degree from Lehigh University in 1948. The Institute has a staff of about 80, including 6 professors, 50 senior researchers and engineers, and about 20 part time research fellows. The Institute offers both MS and Ph.D. degrees. The Polymer Materials Institute at SUU contains the State Key Laboratory of Polymer Materials Engineering (SKLPME). The SKLPME is one of seven state Pilot laboratories supported by a World Bank loan. It has a permanent staff of 20 and 30 other staff associated with the Laboratory.

Activities and Assessment: The work at the SKLPME ranges from average to very good. The Laboratory is involved in polymers for oil recovery (drilling mud additives, demulsifying agents, water treatments), Multicomponent and multiphase polymers systems, polymer processing, fabrication and processing of polymers, plastics for agriculture (mulching, packaging, and biodegradable polymers), polymer interface chemistry, and polymers for photo-electric transformation.

We heard a variety of research presentations. A number of their staff scientists have worked at the University of Massachusetts and University of Akron. All of the proposed collaborations were with the professors with whom they had worked at these institutions.

The SKLPME was the cleanest and best equipped laboratory visited by the polymer team. They had excellent equipment for structure characterization, polymer properties, polymer processing, and polymer synthesis. Several items of equipment were donated. For example, Haake donated about $200,000 dollars worth of equipment including a torque rheometer and an extruder to the laboratory. The SKLPME is clearly interested in having foreign scientists. They have offices for visiting scientists and a guest house. They collaborate or have collaborated with University of Massachusetts, Kansas State University, Ford, and institutions in Japan, Korea, Canada, Germany, and Great Britain.

Proposals

- Applications of Water-Soluble Polymers in Packaging and Agriculture.

  This is a joint proposal to be submitted to the US NSF with University of Massachusetts at Lowell

- Liquid Crystal Thermosets and Composites.
- Bismaleimide Matrix for High-Performance Composite Manufactured by Resin Transfer Moulding.
- High Performance Engineering Plastics Based on Poly(para-phenylene).
- Low Shrinkage fiber reinforced Advanced Composites of Benzoxazine.
- Polymer Crystallization Under High Pressure.
- Molecular Design of Novel Polymer Compatibilizer--Theory and Application.
- Design and Control of Morphology of High Performance Composites.
- New Coloring Technology of Aluminum and its Alloys.
- Thermal Sensitive Switch Made of Mn-Zn Ferrite.
- PVC Oligomer for Plasticizing PVC.
- Ionomer Toughened HDPE, PP, and PPO/PS.
- Investigation of Phase Behavior and Applicability of Time-Temperature Superposition Principle for Xenoy Resin.
- High Density Polyethylene Based Materials and its Application for Slurry Transportation.
- Test Rig for Long-time Cracking of Polymers and its Application.
- Foamed Polypropylene Boards and Profiles for Construction.
- PMN-PFR Shutoff Agent at High Temperature and Salinity for Oil Filed Exploration and Exploitation.
- PDR Oil Phase Drag Reducer.
- Preparation of New Polymer Materials for Damping Vibration and Noise.
- Metal-like Polycarbonate.
- SK Super Absorbent Polymer.
- Polymer Materials for Cable: polyphenylene oxide based communication cable; CQS 911-PE

Insulation Material for Communication Cable; HDPE Sheathing Materials for Optical Cable; PP Insulation Material for Communication Cable; Radiation Crosslinking Polyethylene; Silane-Crosslinking PE Insulator in Power Cable.

Recommendations: This would be a very good institution to collaborate with. Polymer synthesis would be the best area for collaboration. The best kind of exchange would be a synthesis effort at the SKLPME with the advanced characterization done in the US. Samples and data could be exchanged. Short term visits would help this collaboration. This Institute has state-of-the-art equipment and a capable staff and would be a good candidate such visits.

East China University of Science and Technology, Shanghai

Visited by: Barton, Crouch, Thomas

Contacts: Prof. Xu Zhongde, Deputy Director, Institute of Polymer Science and Engineering
Prof. Zhou Dafei, Director of Institute of Material Science and Engineering
Prof. Han Zhewen, Professor, Polymer Science
Prof. Wu Pingping, Professor, Polymer Science
Prof. Fang Bin, Electrically Conducting Polymer Laboratory

Description of the Institute: ECUST, formerly known as East China University of Chemical Technology, is one of the prestigious Chinese universities and is one of the key universities under the auspice of the State Education Commission of China. The university has about 9,000 students and 1,800 academic staff members including 600 professors and associate professors. Currently about 700 students are pursuing advanced degrees.

Activities and Assessment: Prof. Zhou Dafei stated that the current emphasis in polymer science was in polymer alloys, physics of polymer processing, stabilization of inorganic particulate dispersions in polymers and kinetics of copolymerization. Funding for research comes both from government and industry. They also obtain funds by licensing their technology, not by selling any actual products. The research breakdown is about 2/3 applied and about 1/3 basic. The team did not see any working laboratories at ECUST but the equipment described was not extensive.

Proposals

- Polymer electrolyte systems for batteries.

  The work described by Dr. Fang Bin was previously published by him in Polymer Communications in 1991.

- Poly-3-alkylthiophenes.

  Dr. Fang Bin described research on these extensively studied electrically conducting organic polymers which is similar to those previously published papers by U.S. scientists Fred Wudl and

Alan Heeger.

- Rigid-Rod Polymers.

  Prof. Pingping Wu described their ongoing studies on PBZT, poly-p-phenylene benzobisthiazole and the oxygen analog PBO. These are thermally, oxidatively and hydrolytically stable polymers which have been spun into high performance fibers. The team felt that collaboration with a number of U.S. academic groups would be beneficial to this effort.

Recommendations: The polymer team would recommend some form of follow up on the activities in this institution.

Shanghai Institute of Organic Chemistry (SIOC)

Visited by: Barton, Crouch, Thomas

Contacts: Prof. Zheng Chong-zhi, Professor and Deputy Director

Description of the Institute: This institute was formed by merging the Institute of Chemistry, the Institute of Chemistry of the Central Academy of Sciences and the Institute of Materia Medica of Beiping Academy of Sciences in 1950. The present name was instituted in 1970. There are more than 1,400 employees of which more than 500 are in the "Development Company". There are 11 research departments, two companies and a graduate school. Most of the emphasis seems to be in natural products chemistry about which the team was told little since it fell outside of the team's mission. There is a Department of Organic Materials Science and Polymers.

Both the director and deputy director are appointed by the Chinese Academy of Sciences. They oversee the expenditure of funds and set direction for the institute. Deputy Director Zheng stated that one of their goals was "to make money". Ten years ago 100% of the Institute's funding came from CAS, five years ago, 50% and today about 15% although the total annual funds from CAS has remained unchanged each year. This has been accomplished by setting up several companies (e.g. Fine Chemicals, Vitamins B, C, and E jointly with a pharmaceutical company). The institute is very well equipped in terms of buildings and laboratories and the instrumentation necessary for organic chemical research. For example, they have 12 NMR's including a 600 MHZ instrument and a 400 MHZ is on order. They actually construct much of their laboratory apparatus in-house and have excellent glass blowing facilities.

Collaborations: The only suggested collaboration was in the production of beta-crystalline polypropylene (the normal form is alpha-). However it was later revealed that this technology is already licensed to Aristech Co. in the U.S. Where this institute has had the most U.S. interaction is with developing computer databases for organic chemicals where they have done contract work for Chemical Abstracts and STN. The most appropriate collaborations may be contract research or licensing with the U.S. industry.

Shanghai Jiao Tong University

Visited by: Barton, Thomas, Crouch, Schwartz, Ritchie, Liu, Wadsworth, Dragoo

Contacts: Prof. Bai Tong-shui, Vice President of SJTU, Deputy to the National People's Congress
Prof. Sheng Huanye, Vice President of SJTU
Prof. Sheldon Huang, Director, Scientific Research Division, Vice-Dean, Institute of Computer Science and Engineering
Prof. Wu Jian Sheng, Chairman, Dept. of Materials Science, Director, Inst. of Materials Science and Engineering
Prof. Zhang Guo-Ding, Director, State Key Lab. for Metal Matrix Composite Materials
Prof. Sun Li-Min, Assoc Prof., Institute of Polymeric Materials
Prof. Gu Mingyuan, the Associate Director of this Laboratory.
Prof. Lin Dongliang (T. L. Lin), Director, Institute of Materials Science and Engineering
Prof. Hu Geng-Xiang, Professor, Department of Materials Science
Prof. Jin Yao, Deputy Chief, Division of International Exchanges

Description of the Institute: SJTU was established in 1896 as Nan Yang Public School and in 1922, it became the first communication university specializing in communication technologies. As such it has a long tradition of excellence in electronics, computers, machine intelligence, and modern information technologies. It has many famous alumni throughout the world, the most notable being Mr. Wang On who established the Wang Computers in the US. During the last 15 years the State has invested heavily and the student body has increased from 5,000 to a current 13,000. It is mainly an engineering institute but they now have other programs in management and social sciences with a total of 30 departments. The university is recognized by the government as a "key of key" university and is considered to be one of the top five universities in China. The University has just received a donation of $10M by a Hong Kong shipbuilder alumnus to build a library! They have two designated state key technology centers , one in composites and one in high density magnetic storage. The university is situated on two campuses. The team visited only the older and smaller campus and viewed as one of the best facilities they saw in the trip. Presumably the new campus is even better. The University has twelve university-owned enterprises and a 52.8% majority share in a holding company which has four factories, twelve technical service companies, and five joint venture companies with Japan, US, and Singapore.

The university was visited by two teams, one team consists of Liu, Wadsworth and Dragoo and they focused on the intermetallics program. Another team consisting of Barton, Thomas, Crouch, Schwartz and Ritchie, which dealt with the composites and polymeric science programs. The first team heard reviews of the work on intermetallics, shape memory alloys, intelligent materials and structure, metal matrix composites, and computational materials science and visited several laboratories for materials characterization and testing. The second team split into two groups with one visiting the composites laboratories and the other listening to presentations on the polymer science programs.

In the general area of materials, it is served by the Department of Materials Science, Department of Materials Engineering, Institutes of Composite Materials, Polymer Materials, and Fine Chemicals, and an Information Storage Research Center. In addition, it houses the new Research Institute of Materials and Chemical Engineering, the Research Laboratory of SEDC of High Temperature Materials and High Temperature Testing, and the State Key Laboratory of Metal Matrix Composite Materials.

Activities and Assessment:

Polymer Institute: The institute has 24 professors and 52 technical staff members. A wide variety of projects were presented and the nature of the projects appear to be similar to those at the other institutions visited by the polymer team. There was a presentation by N. C. Liu (Assoc Prof.) who had just returned from Canada after getting his Ph. D. at the Queen's University with W.E. Baker. He proposed collaboration in modification of "crumb rubber" from scrap tires to allow it to be used in recycled materials. The proposed plasma treatment was probably not economically feasible. Liu also proposed work in melt grafting (e.g. maleic anhydride to polypropylene via free radical reactions). Of most interest was Liu's work in polymer alloys and blends. While the specific details of his work were sketchy at best, discussion revealed that the best collaboration probably would be with a NIST scientist who could characterize his blends with neutron scattering which is not available to Liu.

Another collaborative proposal was in the area of polyurethane ionomers with ionic conductivity. They have been working with sulfonated polyurethane ionomers using poly- (ethylene oxide) as the soft segment. The main interest was for prosthetic materials with anticoagulating properties. Possibly the major polymer effort in the institute is in polyimides. The work is similar to what has been and is going on in the U.S., Japan, and Europe. They already have collaboration with Hitachi Chemicals Ltd. on polyimides and are negotiating a collaboration with SISIR of Singapore on development of photosensitive polyimides.

Prof. Cihyon Hu is working of carbon- and glass fibers to improve the fiber/matrix interface. Her goal (and everybodies') is to get zero volume change during curing. She claims to have a monomer which does just that but would not reveal the exact monomer. Dr. Schwartz says that NIST may be interested in collaborating in this area.

The Research Institute of Materials and Chemical Engineering: This institute was founded in March 1995 based on an alliance of several departments in the university. They are the Department of Materials Science, Department of Materials Engineering, Institute of Composite Materials, Institute of Polymer Materials, Institute of Fine Chemicals, and Information Storage Research Center. As an entity, it is one of the largest materials research centers in China with the most comprehensive array of equipment and would be capable of tackling large scale projects in materials.

The activities in this institute are varied and comprehensive in scope. They include: metal matrix composites, functional composites, biomedical materials, carbon matrix composites, magnetic materials, high temperature intermetallics, superalloys, functional alloys, thin film electronic materials and microfabrication research on MMDs and MEMs, and materials processing research including computer simulation and control. It also has an extensive surface engineering research and facilities involving in PVD, CVD, coatings, powder metallurgy, and multilayer composite coatings.

Its microfabrication facilities and research are among the best in China

Many of the research activities in materials researach appears to be in processing. In the State Key Laboratory on metal matrix composites, a wide range of projects are associated with the processing of fiber, particulate and whisker reinforced composites (principally aluminum based), characterization of their microstructures and mechanical properties, and perhaps most importantly their application to industry (principally automotive). In addition, they specialize in the high-temperature mechanical properties of these and other materials, specifically focusing on alloy design, oxidation resistance, microstrucutral stability, creep and fatigue properties.

In the area of high-temperature materials, the Material Science Department has excellent strength in intermetallics and in the superplasticity in these materials. Work was initiated in the early 1960s in arc-casting of superalloys. By 1974 work was begun on directional solidification for turbine blade applications. Currently, work on growth of single crystals is in the research stage only. In 1986 they became the first laboratory in China to look at intermetallics, and they have a strong reputation in this area. Their work includes research on NiAl, TiAl, Al_3Ti, Ti_3Al+Nb+Si, and recently Ti_5Si_3. They are actively pursuing research to understand the origins of brittle failure under impact and high strain rate conditions in these materials, despite the fact that these materials exhibit ductility in tension tests at conventional strain rates; support is being received from Pratt and Whitney for this work. Another area within intermetallics, in which they are active, is superplasticity. In this study they have found this phenomenon in Fe_3Al and FeAl. In both cases, the materials have coarse initial grain sizes (approximately 100μm) but develop quite fine grains by some form of continuous recrystallization. Elongations of 300 to 600% have been found.

The intermetallics program also includes studies of oxidation resistance and the development of coatings of Si-modified super alpha-2 or alpha-2 alloys. Research has been initiated on Ti_5Si_3 with alloying additions of Nb. The Nb-modified Ti_5Si_3 exhibited K_{1c} of <10 MPa√m at room temperature. The other areas of research were described in less detail. In the area of shape memory alloys, their emphasis is on NiTi, Fe-base, and NiAl alloys with an emphasis on iron-base materials. NiMg monel products have been developed for China's oil industry, and an agreement has been established with Huntington Industries. Their work on intelligent materials and structure is just underway.

The quality of research in this University was generally high. In particular, their work on metal-matrix composites appeared to be at the forefront of such research within China. Moreover, the application of these materials for structural use, particularly for automotive applications, was well advanced. For example, they had developed silicon carbide particulate reinforced aluminum wheels for the Shanghai-EK Chor Motorcycle Company, and were processing squeeze cast engine pistons, cylinder linings and brake drums with similar alloys. In fundamental studies, they had developed vacuum pressure infiltration techniques for processing carbon or silicon carbide reinforced aluminum or magnesium alloys with extremely high volume fractions (up to 45 vol%) with either fibers, particulate or whiskers. In one process, they actually have been able to achieve even higher volume fractions; using chemical vapor deposition to coat carbon fibers with TiB, they had made carbon-aluminum composites in wire form with a fiber volume fraction of 50-60 vol% (i.e., 3000 carbon filaments per 0.5 mm). These materials are unique, show extremely high specific strength and stiffnesses (e.g., ~150 GPa Young's modulus), yet have very low toughness; their use in industrial applications accordingly is still uncertain.

In materials for electrical applications, they had also developed some interesting carbon/copper composites for electrical brushes; these involve carbon fibers coated with copper within a graphite matrix, where they claim a current carrying density increase of over a factor of four above conventional conductors. They have a factory which is manufacturing this material and is already providing revenue to the University.

The limited equipment facilities that we saw appeared to be very good. For example, they possessed a four-year old Philips transmission electron microstructure, a state of the art scanning electron microscope (also a Philips) with a nano-indentation stage attachment, and excellent smaller pieces of equipment for residual stress measurement, differential scanning calorimetry, and sputter depositors for thin film and functionally graded material studies. In addition, they had a relatively recent MTS servo-hydraulic testing machine, with good high-temperature furnace accessories, designed for both crack-propagation and low cycle fatigue/stress-life studies.

Proposals

- R & D of High Performance and Functional Polyurethane Ionomers.
- R & D of New Types of Polyimide for Electronic Applications.
- A Study on the Application of Crumb Rubber of Scrap Tires to Rubber and Plastics Products and Asphalt Materials.
- Development of Inexpensive Processing Routes for Manufacturing Metal-matrix Composite Components for Both Structural and Electrical of Importance (here is the use of aluminum and magnesium based composites for automotive applications).
- Applications of Metal-matrix Composites with High Volume Fractions (>40%) of Reinforcement Phase.
- Surface Coating Using Sputter Techniques for a Wide Range of Applications, e.g., Diamond Coating on Metallic Prosthetic Devices for Improved Biocompatibility.
- Five Areas for Possible Cooperation Between the U.S. and China in Intermetallic Research Were Suggested by the Materials Science and Engineering Departments: (1) Superplasticity, (2) High Strain-rate Effect, (3) Dislocation Dynamics, (4) Microstructural Design of Two-phase Intermetallic Alloys and (5) High Temperature Intermetallic Alloys

Recommendations: This is one of the best equipped university the team has seen in this trip. The research activities appear up to date and are comparable to the US universities. It certainly is one of the place where bi-lateral cooperation should take place. The strength of the metallic materials based programs at Shanghai Jiao Tong University lies with the processing of composite materials. In the U.S., the use of metal matrix composites has been extremely limited primarily because the properties have not justified the increased cost of these materials. However, the automotive industry has shown interest provided the alloys can be processed inexpensively. It would appear that some of the unique processes techniques used here would be of interest to Ford and General Motors; in addition, Alcoa which has maintained a small but steady investment in metal matrix composites may also be interested.

Institute of Metal Research, ACS, Shenyang

Visited by: Schwartz, Ritchie

Contacts: Prof. Li Yiyi, Director, the Institute of Metal Research
Prof. Ye Hengqiang, Fundamental Research Division
Prof. Wei Wenduo, Director, Enterprises
Dr. Young, High Performance Homogenized Alloys Center
Prof. Wang, Director, State Key Laboratory in Fatigue and Fracture.

***Description of the Institute*:** The Institute of Metal Research (IMR) in Shenyang is recognized as one of the top research and technology institutes operated under the auspices of the Chinese Academy of Sciences. Directed by the well known metallurgist, Professor Li Yiyi, it consists of several research and technological centers (including a Graduate School), a general company for the development of new materials and three State Key Laboratories in "Fatigue and Fracture", "Rapidly Solidified Non-equilibrium Alloys" and "Atomic Imaging of Solids". In addition to such State-funded Key Laboratories, they have a National Engineering Research Center for "High Performance Homogenized Alloys", an International Center for "Materials Physics", a Liaoning Province Key Laboratory for "Materials and Hydrogen", and a Shenyang City Young Scientist for "Magnetism and Magnetic Materials". The total staff of the Institute numbers 1170, including 806 research and development staff (of which 76 are professors and 178 are associate professors and senior engineers), 64 management staff, and 300 workers.

Activities and Assessment: The activities of the Institute are extremely varied. In addition to publishing three academic journals, *Acta Metallurgica Sinica*, *Materials Science and Progress*, and the *Journal of Materials Science and Technology*, their basic research focuses primarily on new materials, processing, and application and development, with a ranking based on published papers in the top five of all of China. Moreover, the revenue-producing activities, both at their Shenyang location and also at a remote plant, looked highly organized and profitable, being centered on the production of products made from conventional materials, i.e., stainless steel and copper tubing. They also processed many advanced materials, e.g., intermetallic compounds such as α_2-Ti_3Al and exotic composites such as BARRAL (aluminum-matrix/bamboo-infiltrated laminate, similar to ARALL), although it was uncertain whether such materials have been produced for commercial revenue. However, their business strategy is to focus on conventional products for the domestic market, and to seek a significant share of this vast and growing market share in order use the profits to fund basic research and R&D for future products. Currently, their claim is that 50% of the funds to run the Institute are derived from such revenues.

The quality of research in this Institute appeared to be very high. Not only are their activities extremely varied, but they enjoy considerable international cooperation with the U.S., Japan and Europe. For example, their Fatigue and Fracture Laboratory has made a name for itself in the fundamental materials science of fatigue deformation and has Professor Campbell Laird of the University of Pennsylvania as an honorary professor. Similarly, they are strong in welding and cryogenic materials, and have Professor J. W. Morris from Berkeley as an honorary professor. Their research in these conventional metallurgy areas is performed with good equipment and appears to be comparable to that seen in many U.S. institutes and universities. However, their research on the processing and mechanical properties (particularly fatigue) of single crystals and bi-crystals was first rate. They can process a wide range of metallic, composite and intermetallic materials using Czychralski, vertical and horizontal Bridgman and floating zone techniques. This facility has the capability of producing 30 x 80 mm single crystals of intermetallics such as Ni_3Al, which can be duplicated by only one or two laboratories in the U.S.

A further indication of the quality of their work is their heavy emphasis on publishing their research in international journals, where they are ranked among the best in China. Although this does not always provide a precise reading on quality or innovativeness, it is nevertheless a good measure of their high standing in the international research community.

Conversely, in the areas of magnetism and non-destructive testing (NDT), their equipment was less up to date and manned by younger, less well-known researchers. They have the intent to visit Los Alamos next year and were very interested in accessing the U.S. high field facilities. Similarly in NDT, their work was focused on very specific tests for product quality in a post manufacture mode, and was conducted with general equipment which could be updated. Our overall impression was that their facilities were excellent and comparable to many universities in the U.S.

Proposals

The Study Team received no formal proposals from the Institute. However, certain research areas were discussed and would clearly be of interest to research institutions and perhaps industry in the US:

- Processing of Alloy and Intermetallic Single Crystals and Bicrystals for Mechanical Properties Studies; Characterization of the Fatigue Properties of Such Materials, e.g., for Potential Aerospace Applications.
- Rare Earth Additions to Materials for Mechanical Applications or for Magnetic Purposes.
- Prosthetics Devices, Both Load-bearing (Hip and Knee Implant) and Heart-valve Devices.
- Hydrogen Storage Materials.

Recommendations: Of the many institutes visited within China, the Institute of Metal Research in Shenyang is clearly high on the list for potential interactions with the U.S. IMR has had, and currently has, numerous students in U.S. universities and this has certainly facilitated numerous interactions in fundamental research. These and future interactions should certainly be encouraged. The primary topics of interest would appear to be in the processing and mechanical property evaluation of conventional structural materials, with particular emphasis on single crystals and bicrystal research. In this regard, U.S. aerospace companies, such as GE or Pratt and Whitney, may also be interested in their facilities for processing such materials.

Clearly the strengths of IMR in research can be characterized by the processing and mechanical property characterization (especially fatigue and cryogenic properties) of conventional structural materials. Specifically, their ability to process large single crystals and bicrystals of Al, Al-Zn, Al-Mg, Al-Cu, Al-Li, Zn, Cd, Cu, Cu-Zn, Cu-Al, Fe-3%Si, Ni and especially Ni_3Al would be of particular interest to universities and industry alike in the U.S. Also their revenue-bearing enterprises appeared to be very successful; any U.S. company wishing to "break into" domestic Chinese markets would probably find interactions with IMR to be of immense value in this regard.

Forms of Exchanges: This Institute is clearly a prime site for possible interactions and collaborations with the U.S., both from the perspective of fundamental research and possible joint ventures into the domestic Chinese marketplace. The many interactions that are currently in place between IMR and institutions in Asia, Europe and the U.S. are clearly evidence of this. In our discussions, the following specific collaborations were discussed:

- The creation of joint workshops - including a specific one on high performance materials to be arranged at IMR in 1996.
- A "business fair" in the U.S. to allow IMR and other Chinese Institutes to display their products, current or potential, with an eye towards sale or joint venture enterprises.
- Specific areas of research including alloy and intermetallic single crystals and bicrystals for mechanical properties studies; rare earth additions for mechanical or magnetic purposes; prosthetics devices; hydrogen storage materials; evaluation of brittle materials; and the intelligent processing of materials.
- Broad area cooperation in alternative materials, recycling and alternative processing for environmental impact.
- Access to special facilities in U.S. in the form of specific SSTC travel grants to those who are successful in having their proposals funded at a U.S. facility.
- Standards, including round robins, training in standards including ISO 9000, and testing in Chinese labs to produce data bases after quality assurance has been developed. The question of immediate access to standard reference materials (SRMs) at reduced or no cost was of particular concern here, and whether World Bank or equivalent funding could be secured to support this.

North-Eastern University, Shenyang

Visited by: Schwartz

Contacts: Prof. Wang Qiyi, Vice President, North-Eastern University
Prof. Sun Xudong, Director, Ceramic Division, Department of Materials Science & Engr.
Prof. He Kai-yuan, member of Special Committee of Magnetism

Description of the Institute: the State is identifying 100 universities as research schools (elite strategy) and this is one of 30 which have already been chosen through examinations. The total number of students are 15,000 with 1,600 graduate students. There are 1,700 faculty members with 23 doctoral programs. National programs in mining and metallurgy are located here. This is an university with a large teaching load and each faculty has about 30% of time for research. At the same time, they have some of their own "enterprises" to generate additional resources. The real strength of this school is apparently in the computer science area, and they have a new building and were breaking ground for another (for software development) on the very day of the visit.

Activities and Assessment: Materials science, including ceramics, includes about 70 faculty in several departments. The research activities include: intermetallics; metals processing; magnetic materials; ductile phase toughened ceramic matrix composite in alumina-Ni-Fe-Mo systems; ceramic nano-composite; CaO-CeO_2 composite for the melting crucible of titanium alloys; Al_2O_3-metal functionally gradient materials using powder metallurgy process; processing of sub-micron sized SiC powder and sintering of SiC; SiC/Si_3N_4 composites; and MgO-C composites for refractory applications. Many of the equipment in the laboratory were old and could use some modernization. Most of the research activities follow the established areas in the literature.

Proposals

- Hydrogen Induced Superplasticity of Ti_3Al Intermetallics.
- Liquid-Solid Rolling Bonding of Metals to Produce Clad Metal Sheets or Strips.

  One metal is in liquid state while the other is in the solid state when they are rolled together, the liquid metal is crystallized and forms a very strong bonded layer under rolling conditions.

- Super-magnetostriction Materials and Mechanism.

  Casting with electromagnetic stirring to produce small grain size, magnetic alloys with rare earth components

- Study on Phase Transitions of High Magnetic Induction Fe(Si)-N Material System.
- Ceramic nanocomposites of Al_2O_3-SiC-YAG, Al_2O_3-Si_3N_4, MgO-SiC systems.

Recommendations: Materials research activity in this university is growing. Currently, the ceramics activities appear to be quite strong. In the future, this institution may play a significant role in this geographic location in China. Future follow-up visits by ceramic researchers would be warranted.

Institute of Corrosion and Protection of Metals and Corrosion Science Laboratory, ACS
Shenyang, Liaoning Province

Visited by: Ritchie

Contacts: Prof. Wu Wei-Tao, Director of the Institute
Prof. Ke Wei, the former Director
Prof. Yao Zhi Ming, the Deputy Director

Description of the Institute: The Institute of Corrosion and Protection of Metals in Shenyang was established by the SSTC in 1982 from research programs that were active in the larger Institute of Metal Research; it is in fact the first institute in China specializing in the science and technology of corrosion science and protection. It is currently directed by Professor Wu Wei-Tao, who is well known in the field of hot corrosion.

Activities and Assessment: The Institute has three primary functions, namely fundamental and applied research in the general area of corrosion, a Graduate School for the education of both Master's and Doctoral students, and a general company for "development and industrial service". It is structured as the State Key Laboratory for "Corrosion and Protection", four research divisions in Corrosion Electrochemistry, High Temperature Corrosion and Protection, Environmental-Sensitive Fracture and Corrosion, and Environmental Corrosion, two service laboratories in testing and technical services (presumably consulting), and a library. The total staff of 230 people includes 15 Professors and 60 post-graduate students, and is housed with ample space in two large buildings; 30% of this staff is devoted to research with the other 70% in marketing.

The Laboratory is funded by the Central Government (25%), by competitive grants/contracts from government and industry (25%) and by revenue derived from industry service and sales (50%). Details on the latter activities were not overly forthcoming, but the Institute was clearly active in consulting for industry and in the corrosion protection of major engineering projects such as oil pipelines and the Three Gorges Dam. Their retail products included a variety of inhibitors, surface treatment equipment, specific corrosion-resistant alloys (e.g., certain grades of stainless steels), coatings and electrodes.

The activities of the Institute are quite extensive in the field of environmental failure and protection of materials. These include a large program in hot corrosion of conventional and intermetallic materials, wide ranging studies on stress corrosion and corrosion fatigue, again in both conventional and advanced materials, and efforts in electrochemistry and environmental pollution. In addition, much of their advanced studies are focused on coatings research. With specific exception, the standard of the research appeared to be comparable with many institutes and universities in the U.S., with highlights in measurement techniques for characterization of mechanical and electrochemical environments near crack tips, and in the rare-earth additions to high-temperature alloys and coatings.

In specific areas, the quality of the research at this Institute appeared to be quite high. This was particularly true in their work on environmentally-sensitive fracture, where they currently are engaged in international interactions with the University of Birmingham (through personnel exchange) and in hot corrosion and in surface modification, where their understanding on the role of rare-earth additions appeared to be quite advanced. In the area of hot corrosion, they currently have interactions with several researchers in the U.S., including Howmet Co. and Boone and Associates, whereas in the area of coatings, they are involved with David Schores of the University of Minnesota. The impression that they gave was that in most of their salient areas of research, they were interacting with prime researchers in the U.S.; however, the extent of this collaboration beyond personnel (i.e., student exchange) was uncertain.

This laboratory in general was relatively well equipped. In addition to the normal electrochemical and corrosion testing facilities, they possessed numerous mechanical testing systems for fatigue and fracture research and had excellent facilities for advanced measurement and characterization (e.g., acoustic emission, Raman spectroscopy, speckle interferometry, and atomic force/scanning tunneling microscopy); moreover, they were developing equipment for the controlled study of erosion and corrosion.

Proposals

The Study Team received no formal proposals from the Institute. However, certain research areas were proposed verbally and would potentially be of interest to research institutions and perhaps industry in the US:

- Rare-earth containing Coatings, specifically involving both Rare-earth Additions to Materials such as Nickel Aluminides and in the Co-deposition of Rare-earths and Coatings.
- Molten Salt Corrosion for Carbonates for Fuel-cell Development.
- Corrosion Control Techniques, Specifically in the Use of Cathodic Protection of Pipelines and Oil Rigs.
- Development of Corrosion Resistance in Steels for Reinforcing Concrete.
- Laser Coating and Laser Welding Studies.

Recommendations: Much of the research observed at the Institute appeared to be comparable on average with that in general universities in the U.S. However, their use of local characterization techniques, in particular the use of speckle interferometry to measure crack-tip strain rates in stress-corrosion and corrosion fatigue studies, was quite advanced and would certainly be of interest to researchers in the U.S. Similarly, their work on the processing and properties of corrosion protection coatings, particularly involving rare-earth additions, was also strong and would also be of interest to both academic and industrial institutions in the U.S.

This is clearly an Institute within China where collaboration with universities, laboratories and possibly industry in the US would be welcomed. In the area of coatings, particularly where it involves the use of rare-earth additions may well be of appeal to specific aerospace industries within the U.S. Clearly, they have measurement techniques which would be of interest to U.S. researchers and can process coatings which could be characterized and evaluated in the U.S. Industry may also be interested in their work on coatings; for example, they are responsible for designing coatings for the directionally-solidified turbine blade material (termed *DD3*) which has been developed by the Institute of Aeronautical Research in Beijing for possible use by Pratt and Whitney.

Institute of Metallurgy, CAS, Shanghai

Visited by: Schwartz, Ritchie

Contacts: Prof. Lin Sin-ru, Deputy Director

Description of the Institute: The institute was founded in 1928 as part of the National Research Institute of Engineering. Over the years, three research institutes were spun off: Changsha Institute of Mining and Metallurgy in 1956; Kunming Institute of Noble Metals in 1959; and Shanghai Institute of Ceramics in 1960. In the 1960s, the institute began to focus on ultra pure metals, semiconductor materials and devices, integrated circuits, magnetic and superconducting materials, corrosion and protection of metals, and ion beam technology and its applications. Today, its activities are mainly in three areas: microelectronics, functional materials and devices, and corrosion and protection of metals.

They have three campuses: headquarters, branch of microelectronics, and SIMTEKPARK (a high technology park). The institute has 1,200 employees, about 800 are scientists and technicians with 50 professors and 100 graduate students.

Activities and Assessment: The major technical activities are focused in microelectronics and the related technical areas. There are 23 departments in all, of which four are state key laboratories and one is the Center of Computer Aided Design and Mask Fabrication. At the headquarters, the State Key Lab. of Functional Materials for Informatics (sensors and devices) and the State Key Lab. of Transducer Technology (micromachining, micro-electromechanical devices, biological transducers) are housed. Other activities are ion beam lab., lab. of optical disks, packaging, optoelectronic devices, and integrated circuits. They seem to be very well equipped, and the modern MBE machines they showed us confirmed this. One purchased last year from UK, and the other a two-chamber version which was home-made six years ago. Their list of activities, focussed on GaAs, InP, and GaSb runs the gamut from crystal growth to device fabrication at the pilot plant level. Manufacturing will be carried out through joint ventures, several of which already exist with Dow, Dupont, and Daimler Benz as well as with Chinese companies. The venture with Dow has brought them a complete fabrication line at the 4" size. The venture with Dupont is on mask fabrication and will commence manufacturing next year. The venture with Benz is focused on packaging and includes research as well as manufacture.

Many of the staff have spent some periods abroad each year, about 30 are sent out each year. The person running the MBE had spent two years at the Tokyo Institute of Technology. Potential areas of collaboration were listed as IC chips using their 4" line, use of new materials in devices (semiconductors, magnetic and superconducting hydrogen storage), and prosthetic device surface treatments. When asked why they believe any company would form a joint venture with them, they emphasize their low cost production and the opportunity to establish a foothold in China through their organization. Regarding cooperation with universities, their only offered mode was one in which they send students to the universities. They mentioned the following areas for possible research cooperation: informatics, magnetism, high temperature corrosion, and lubricating oils.

University of Science and Technology of China, Hefei, Anhui Province

Visited by Hsu, Becher, Kramer

Contacts: Dr. Tang Honggao, President of the University, Alternate Member of the Central Committee of the Chinese Communist Party
Dr. Wu Geng Feng, Director, Scientific Research Division
Dr. Meng Guang-Yao, Director, Solid State Chemistry and Inorganic Membrane Lab.
Dr. Qingliang Liu, Professor, Applied Chemistry, in charge of technology commercialization
Dr. Shu-Sheng Chen, Associate Professor, Applied Chemistry

Description of the Institute: The University of Science and Technology of China (USTC) was founded in Beijing in 1958 and moved to Hefei in 1970. It is the only university in China that is a unit of the Chinese Academy of Sciences, with faculties of science, technology, arts and management. The budget of the University is approximately $20 million per year, with $5 million provided by the Chinese government and the remainder from research grants and contracts. There is not much emphasis on commercial ventures, which are felt to be too distracting from the fundamental research emphasis.

The University has 6 faculties with 20 departments and 3,440 staff, including 1,850 faculty. Total enrollment is 6,080, with 966 full time graduate students and 3,855 full time undergraduates, with the remainder evening and part time students. USTC has sent 4,000 students to the U.S. in the past 16 years and hosts approximately 600 visiting scholars (mostly from the U.S. and Japan) each year.

USTC has been targeted to become a world class institution, with a huge new campus under construction. It has maintained a strong focus on fundamental research and is one of the top three institutions in China for producing research papers in materials. It's curriculum is distinguished by a special emphasis on computer applications in all disciplines.

Activities and Assessment: The University conducts a broad range of research that relies on the excellent analytical facilities that are available. From the papers the University has published, electronic materials, optoelectronic materials, electro-optical devices, thin films, coatings, crystals growth are major activities of the university. The team however did not get to see those activities. Of the materials we saw, the major emphases appear to be on the preparation and characterization of high temperature superconductor materials and on the surface interactions of gases with semiconductor and metal surfaces. We spent some time with Professor Meng's group, which specializes in chemical vapor deposition processes. The group has excellent capabilities, in that they have the ability to synthesize metallorganic precursors to enable the design of custom MOCVD processes for deposition of desired species. The group achieved the MOCVD of YBCO high temperature superconductors in 1988. They are very interested in collaborating with U.S. researchers, indicate that they can do CVD of "anything" and that the synthesis of single source precursors is a particular strength of the group.

USTC has a resource unique to China in the Hefei National Synchrotron Radiation Laboratory (HESYRL), which is located on campus, came on-line in 1992 and was constructed at a cost of approximately $10,000,000. The electron storage ring of HESYRL has a nominal energy of 800 MeV and the capability to support 50 beam lines, 5 of which are in use with plans to make 9 additional lines operational in the near future. The beam lines are dedicated to photolithography (particularly LIGA), biological studies (particularly cancer cells), characterization of semiconductors and crystals, fluorescence studies and atomic and molecular absorption spectroscopy. It was indicated that they would be interested in building beam lines for U.S. researchers at low cost.

The Research Center is equipped with modern TEM, SEM, NMR, XRD and XPS analytical equipment purchased from U.S., Japanese and European manufacturers with World Bank support. The synchrotron light source is not expected to be of the quality or intensity of competitive sources in the U.S., but is a remarkable facility, given the cost of development. The CVD laboratory was equipped with bench scale equipment suitable for the development work that is carried out in the laboratory.

Proposals

- Preparation of Ultra-thin Oxygen Separation Membranes.
- Preparation of GaN and AlGaN Crystal Layers for UV/blue p-n junction Diodes by Plasma CVD Processes.
- Preparation of AlN layers by Plasma CVD.
- Preparation of Tough Ceramic Membrane supports with large Porosity and Uniform Pore Size.

Recommendations: The MOCVD group seems to have excellent capabilities and could be an excellent resource for application-oriented research groups in the U.S. Access to a synchrotron light source may be of interest to some research groups. Cooperation will depend on the individual fit of research interests, but strong areas of expertise exist that will enable productive collaborations with both university and industrial laboratories. Application-focused research in the U.S. coupled with synthesis efforts at USTC may be particularly interesting.

Academia Sinica Institute of Plasma Physics, Hefei, Anhui

Visited by: Hsu, Kramer, Becher

Contacts: Dr. Yuan Xi Wan, Deputy Director

Description of the Institute: The Academia Sinica Institute of Plasma Physics (ASIPP) is a showcase institution, housing one of three operating superconducting tokamak plasma fusion reactor in the world. The focus of the ASIPP is on plasma fusion research, with materials-related activities largely limited to the spin-off of technologies related to tokamak development to device design and materials processing. The Institute has founded 3 small companies which currently generate revenues of approximately 15 million yuan per year. It is planned that approximately 20 percent of Institute revenues will eventually come from associated business ventures.

Materials, magnetic field and microwave technologies are all critical to the advancement of tokamak technology. We saw projects underway involving the magnetic field constraint of microwave plasmas for the deposition of diamond films and the use of microwave energy for the sintering of zinc oxide surface acoustic wave devices. We also saw a joint Chinese-Russian project for the development of high power plasma cutting torch for the cutting of steel slabs, a successful commercial venture producing zinc oxide surge protector devices and an incipient business (first prototype) to produce plasma etching equipment for the microelectronic industry.

The briefness of our visit precluded a detailed understanding of the motivation behind the projects. However, some projects seemed oriented towards observation of the effects of high magnetic or microwave fields on materials processing to see if any significant beneficial effects derive. While the tokamak reactor may be of limited usefulness to researchers in materials science, those developing new materials for application to plasma fusion may avail themselves of a world class facility. The ASIPP is also well-equipped to design and operate apparatuses for high magnetic field studies.

Proposals: No specific written proposals were received. However, the ASIPP has a pending formal agreement with the High Magnetic Field Laboratory at Florida State University and other, ongoing cooperations with the U.S., Russia and France.

Recommendations: Testing of materials for plasma fusion devices and design and testing of materials processing equipment incorporating high magnetic fields and/or plasma sources are the unique strength here. Cooperation will depend on the individual fit of research interests, but strong areas of expertise exist that will enable productive collaborations with both university and industrial laboratories. Application-focused research in the U.S. coupled with device design at ASIPP may be particularly interesting.

Hong Kong University of Science & Technology, Hong Kong

Visited by: Schwartz, Hsu, Ritchie, Kramer, Becher, Crouch, Thomas, Barton

Contacts: Prof. Woo Chia-Wei, President, HKUST
Prof. Eugene Wong, Vice President, HKUST
Prof. Joe Mize, Assoc. Vice President for R & D
Mr. Wesley Nieveen, Asso. Director, Materials Characterization and Preparation Center
Prof. David Barber, Director, Materials Characterization and Preparation Center

Description of the Institute: The Hong Kong University for Science and Technology was incorporated in April 1988 as a world-class technological University. Its objectives are to educate men and women who will contribute to Hong Kong's economic and social well-being, and to promote research, development, and entrepreneurship in the Asia-Pacific region. The university is publicly funded and comprises four schools. The Schools of Science, Engineering, and Business and Management provide both undergraduate and postgraduate education through to the doctorate. The University also includes a number of interdisciplinary Research Institutes and a Technology Transfer Center to facilitate technical collaborations between industry and the University. It has a undergraduate student body of 3,116, and 796 graduate students with a faculty of 360 in the 1993-1994 academic year. Most of the faculty are educated in the U.S.

This is a remarkable institution which has grown from a mere concept seven years ago to a startup campus four years ago and now to a thriving enterprise with more than 400 faculty and 5000 students. Perched on a hill with superb facilities and a magnificent view of the harbor, this University is rapidly becoming a symbol of the technology strategy of Hong Kong. Since 1997 will bring transfer of Hong Kong to the PRC, this University will soon become an integrated part of the China strategy, and should be seen as such today as they prepare for 1997. We met with a group assembled by Wesley Nieveen, Assoc Director of the Materials Characterization and Preparation Center (MCPC), and including , among others: Eugene Wong, VP, R&D, and recently with the U.S. OSTP; Joe Mize, Associate VP, R&D; David Barber, Director, MCPC; LiaoYork, Executive Director, Varitronix Ltd, a local electronics firm; and Wang Pokang, Director, Future Products Development, SAE Magnetics. We were also joined by Mr. T.K. Lau and Mr. Larry Dewey of the U.S. DOE International Policy Office, who were in China on a separate negotiation with the SSTC on energy related agreements and were interested in examining the Hong Kong aspect in relation to the S & T situation in China.

Discussions: In a free-ranging discussion, the team described our mission and our preliminary conclusions about the materials research scene in the PRC. They, too are pursuing interaction with the best of these universities and institutes on the mainland for the same reasons that U.S. companies must - lower cost manufacturing and access to a vast potential market. In addition, there is the obvious motivation associated with the transition in 1997.

In these discussions and later at luncheon with Dr. Woo Chia-Wei, President of HKUST, we discussed the potential impact of the imminent transition of Hong Kong to the PRC. The interdependency between the businesses in Hong Kong and the mainland, already significant, will certainly grow. For example, we were told that manufacturing employment in Hong Kong has decreased dramatically in recent years from ~900,000 to 400,000, but that simultaneously employment of these businesses in the mainland has increased from near nothing to 3.5-4.0 million. HKUST will play a significant role in the linkage between Hong Kong high tech industry and the mainland by their own design as well as with the encouragement of the Hong Kong government. For an example of the latter situation, they are participants in tripartite research teams encouraged by the HK government which are designed to link an HK university, an HK business, and a mainland China institution. In another example of a "broker" relationship, the British government has established a tripartite program intended to link a British university with one from Hong Kong and one from the mainland. They encouraged our team to consider HKUST in this "broker" role in our recommendations to the U.S. government, as well as emphasizing their own capabilities for direct cooperation with laboratories in the States.

Activities and Assessment: We were then taken on a brief tour of the facilities of the MCPC and a related Micro-Electronics Processing Center (MPC). These facilities, housed in superb quarters designed for them, and equipped with a very generous startup grant from the government, are the equal of any in the world. Some would say that as a result of the completely integrated information network and the special design features and fully equipped nature of the characterization and processing equipment, these facilities exceed those found in a single institution anywhere. It was interesting to learn that most of the equipment of the MPC was being purchased from the U.S. In addition to high quality, this was attributed to the U.S. university origin of most of the faculty who will use the MPC, and their predilection to use the equipment they had been exposed to in the States.

We were left with the impression of a superb university in its early developing years, one which will have to be reckoned with in the field of materials research, and one which may serve as a valuable partner and broker in subsequent dealings with mainland institutions.

VII. APPENDIX G.

SUMMARY OF PROPOSALS RECEIVED

During meetings between Chinese researchers and American scientists, the materials study group received numerous proposals for cooperative scientific initiatives. Many of these research projects in advanced materials appear to have progressed through the basic research phase and are now ready for continued development through applied research and small-scale production.

Recent policy changes and structural reform create new international business opportunities in China. An opportunity for technology-based joint ventures exists because Chinese research institutes are seeking Western expertise in transforming basic research results into useful products, developing appropriate advanced manufacturing techniques, and sourcing venture capital.

These proposals demonstrate China's strong desire for international cooperation to accelerate development of emerging technologies. Like other governments around the world, China has discovered that technological innovation requires investment in diverse professional expertise and risk sharing. A plan to encourage foreign research collaboration, seek foreign participation in technology development, and to deepen technology diffusion was announced at the recent PRC National Conference on Science and Technology planning in 1995, the third since 1949.

Tsinghua University, Beijing 100084

Contact: No central contact person, use the names in the site visit report
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Tel: 86-10-259-4579 Fax: 86-10-256-2768

- The Studies on Microstructural Design of Advanced Ceramic Materials and their Tribological Properties
- The Synthesis, Preparation, and Property Evaluations and Development of New Ceramics
- Nanoceramic composites and Bio-active Functional Ceramics
- High Performance Relaxor Ferroelectric Ceramics for Smart Actuators
- Development of New Type of Piezoceramics-Electrorheological Combined Stepper Motors
- Design and Development of High-Temperature Smart Ceramic Composites
- The Crystallization of Glass Ceramics Induced by Electric Field and Current Pulses
- Synthesis of Multilayer Film-Ceramics Composite Materials
- The Study of Ion Implantation in Ceramics:
  A. Diffusion Behavior Study of Ag Implantation in Sic Single Crystals
  B. Optical Property of Nanometer Particles Distrubuted in Implanted Layers of Ceramics
- Biomimetic Synthesis of Bone and other Implant Materials
- Superplastic Deformation of Materials with Non-ideal Microstructures and the Problem of Superplastic Mesoscopic Deformation
- New Type of Graphite Material Used in Environment Pollution Control
- Investigation of Metal/Ceramic Micro-assembled Coatings

- Control of Gradient Morphology of Polymer Blends and their Surface Properties
- Reactivity of Functional Group Monomer in Non-Equilibrium Copolycondensation
- Thermotropic Liquid Crystalline Block Copolymers used as Compatibilizers in insitu composite

Institute of Physics, CAS, Beijing 100080

Contact: No central contact person, use the names in the site visit report
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Tel: 86-10-256-9220 Fax: 86-10-256-8834

- Preparation of High-tc $YBa_2Cu_3O_7$ Superconducting Tapes and the Melt Textured Growth of $YBa_2Cu_3O_7$ Superconductors
- Synthesis of New Materials (High-tc Superconductors and Other Materials) under High Temperature and High Pressure Conditions
- Development of New Techniques Growing New Types of High-tc Superconducting Thin Films on: A.) Special Substrates or Tapes Through Buffer Layers
  B.) Ferroelectric Materials
- Crystal Growth and Laser Properrties of Rare-earth Orthovanadates
- Improvements of Photorefractive $BaTiO_3$ Crystals and Development of New Materials
- Development of New Photorefractive Semi-insulating Multiple Quantum Wells Materials, Devices, and Applications
- Multi-zone Furnace with Computer Controlled Power Distribution
- Research on Materials Science in Space Including: Metastable Alloy under Microgravity, Compound Eutectic Growth of Metals, Crystal Growth in Space, and Applied Space Materials Application Develepment

Institute of Aeronautical Materials, Beijing

Contact: Wu Xueren, Technical Director, Institute of Aeronautical Materials, PO Box 81, Beijing 100095, PRC Tel: 86-010-254-1490 Fax: 86-010-254-6772 or 255-8529

- Development and application of Ti-Al based alloys, relationship between composition, process, microstructure, and properties of these alloys
- Development of oxidation and corrosion resistant Ni_3Al based alloys
- High performance and high volume fraction ceramic particulate reinforced aluminum MMCs
- Rapid-solidification high temperature aluminum alloys: deformation mechanisms & new alloy development
- Particulate-reinforced MMC by spray atomization and co-deposition
- High temperature polyimide composites: improve high temp. Properties and processibility
- Research on cure monitoring techniques of polymer composites
- Nanostructured intermetallics: powder synthesis by mechanical alloying & material formation

Central Iron and Steel Research Institute, Beijing

Contact: Zhu Jinghan, Deputy Director, 76 Xueyuan Nanlu, Haidian District, Beijing 100081, PRC. Tel: 86-010-218-2908 Fax: 86-010-218-1018

- Development of Magnetic Components
- Research on Hydrogen Storage Materials with High Capacity, Fast Activation and Long Cycle Life for Electric Vehicles
- Grain Boundary Segregation of Sn in Fe-Si Alloys and Its Influences on the Texture and the Normal Grain Growth
- Co-continuous Nickel Aluminide-ceramic Composite
- Fabrication and Evaluation of SOS-6 SiC Reinforced High Density Ti_3Al Intermetallic-based Composites
- Investigation on Functionally Gradient Ceramic Film Coated by Self-propagation High Temperature Synthesis (SHS)
- R&D on Low Activation Oxide Dispersion Strengthened (ODS) Ferritic Alloys for Commercial Fast Breeder Reactor (FBR) and Fusion Reaction Applications
- Studies on Microstructure Properties and Application Development of Some Advanced Ceramic Matrix Composites

NERC/Magnetic Materials, Beijing

Contact: Prof. Rao Qilin, Vice President, 1, Wenxing St., Xizhimenwai, 100044, Beijing, PRC Tel: 861-8322211 Fax: 861-832-1362

- Anisotropic Compounded Materials Of Rubber (Or Resin) And Hard Ferrite With High Magnetic Properties
- Research on the Th_2Fe_{17} Type 2:19 Monclinic Permanent Magnetic Phase in Sm-Fe-M(ti) Alloys
- Oriented Particle Deposition of Sm_2Fe_{17} Film with Nitrogen Penetration to Make Anisotropic Magnetic Films

Beijing University of Chemical Technology

Contact: Dr. Lu Yafei, Box 101, BUCT, Beijing 100029, PRC Tel:86-10- 421-8855 Fax: 86-10-421-4487

- Development of Pan Based Carbon Fibers: Synthesis of Acrylic Copolymers and Spinning; Preparation of High Performance Carbon Fibers and Graphite Fibers
- Development of Pitch Based Carbon Fibers: Mesophase Pitch and Spinning; High Modulus Pitch Based Carbon Fibers
- Activated Carbon Fibers
- Conductive Paper of Carbon Fibers
- Sizing Agent and Oil for Carbon Fibers
- Application of Short Carbon Fibers Reinforced Thermoplastics

- Rtm Technology and Products
- Thin Walled Composite Products
- Synthesis of Engineering Plastics
- Inorganic/organic Fillers Filled Thermoplastics
- Interphase of Polymer Composites

Beijing Research Institute for Non-ferrous Metals

Contact: Prof. Wang Dianzuo, President, General Research Institute for Non-ferrous Metals, 2 Xin Jie Kou Wai Dajie, Beijing 100088, PRC
Tel: 86-10-201-4488 Fax: 86-101-201-5019

- Rare earth chemistry and material design--this is a well written proposal involving phase diagrams, theoretical calculations, and application research in various product areas.
- Study of manufacture and application on discontinuous fiber reinforced metal matrix composites
- Aluminum nitride metallization in microelectronics: Cu-AlN direct bonding by Active element thin film
- The development and manufacture of MH/Ni battery for electric vehicles
- A study on silicon nitride strengthened and toughened by dispersing particulates
- A study on the compaction and characterization of nanophase materials (metals)

Lanzhou Institute of Chemical Physics, CAS, Lanzhou

Contact: Prof. Xue Quinji, Vice President of the Institute, Director, Lab. of Solid Lubrication
PO Box 97, Lanzchou 730000, Gansu, PRC
Tel: 86-931-22871-983 Fax: 86-931-417088

- The Wear and Lubrication of Ceramics

  This is a proposal to study lubricating mechanisms of lubricants and wear mechanisms of ceramics and to develop wear models in terms of mechanics and chemistry. The collaboration would seek to optimize solid and liquid lubricants and find several ceramics suitable for high temperature applications. Ceramics to be studied would include Si_3N_4, SiC, Al_2O_3 and ZrO_2, metal oxides and rare earth compounds.

- Self-lubricating Surface Modification of Aluminum Materials

  A collaboration is proposed to study the structure and composition of aluminum metals and their anodized films toward overcoming the poor tribological properties of aluminum-based materials. Friction and wear mechanisms will be investigated for different friction conditions. The proposed study would develop micro-embedded self-lubricating anodized aluminum through in situ synthesizing solid lubricants in the porous structures of anodized aluminum or through depositing solid lubricants by physical, chemical, and electrochemical methods.

- High Temperature Wear-resistant Alloys

  The proposed collaboration would seek to improve the high-temperature (800°C-1000°C) properties of Ni-based alloys strengthened with nanosized ceramic particles and to develop high temperature solid lubricants. Possible dispersion strengthened alloys and solid lubricants will be surveyed with respect to preparation, tribological properties, composition, microstructure, and tribochemistry in different environments.

Gansu University of Technology, Lanzchou

Contact: Chen Jian-Hong, President of Gansu University of Technology

- A Proposed Cooperative Research on the Advanced Materials Project between P.R.C. and U.S.

  This is a broad study on advanced materials and processing and covers most advanced materials issues.

- Surface Coating Materials

  A proposal to modify surface properties for repair or protection of machine parts. Such a project could take advantage of the natural resources through the development of nickel based coatings (e.g., Ni_3Si, which is very resistant to acid attack) in collaboration with U.S. researchers.

- Development of Ni-base Brazing Materials of High Temperature

  Ni-base brazing materials are required for brazing high-temperature alloys and stainless steels. Again, this project plays to the strength of the natural resources of Ganzu province.

- The Mass Transfer Effects of the Modified 9Cr-10Mo and 9Cr-1 Mo/SUS 316 Weldments under Long-term Exposed to sodium at Elevated Temperatures

  This project was somewhat specialized and deals with long term reliability of some welds in liquid metal fast breeder reactors.

Zhejiang University, Hanzchou

Contact: Prof. Tang Jinfa, University Vice President, Professor of Optical Engineering
Hanzchou 310027, PRC Tel: 86-0571-795-1846 Fax: 86-571-795-1358

- The Present Status of Metal Hydride Research, Development, and Industry in the People's Republic of China

  Presented by Dr Qi-Dong Wang, et al. They are studying AB_5 and AB_2 (Lave's phases) compounds with an emphasis on incorporation of mischmetal (La, Nd) as a strategic use of material resources for hydrogen storage in Ni-metal hydride batteries.

- BioMaterials Work Incorporating TiNi Shape Memory Alloys

  Presented by S.C. Wang. They are looking to remove the influence of Ni because of its toxic potential by growing Ti rich surface oxides and ternary alloying (such as Cu). It is worth noting the ease with which now biomaterials can be tested in humans in China by comparison with the US (No proposal attached or provided).

- A Study on the Copper-based Shape Memory Alloys

  Presented by J.Q. Chen, et al. The main thrust is to increase the temperature range of use for Cu-base shape memory alloys (based on Cu-Zn-Mn composites).

- Fe-Mn-Al-Cr Austenite Stainless Steel

  Presented by Cai-jin Chen. This is fully austenitic stainless steel but with no nickel and reduced Cr. The alloy has good strength and ductility at ambient temperatures. Further research is required to solve a problem of hot-cracking during welding.

- Research in Surface Engineering of Cermets

  This work is centered on (a) TaC cermets used for particle erosion resistance, and the development of CVD coatings and (b) siliconized and carbonized wear resistant surfaces on Cu sheets at low process temperatures.

- Retreatment of Plasma Sprayed Coating

  Proposed by Mi Yang. Work in this area is focused on coating medium carbon steel substrates with Fe, Ni, and Cu based alloys for magnetohydrodynamic applications.

- A Quantitative Microstructural Analysis of Fatigue Crack Growth

  Proposed by Jinshan Song. The work is focused on LY12 (US equivalent Al-2024) in the T4 and overaged conditions. Low frequency cyclic fatigue measurements have been carried out.

- The Cooperative Study of Nanostructured Materials

  Proposed by Wu Xijun on the general basic research on nanostructured materials including powder, processing, characterization.

- A Quantitative Microstructural Analysis of Fatigue Crack Growth.

  Proposed by Song Jinshan. This project is trying to understand the effects of inclusion, dispersoid, precipitate, and grain boundary phase on the process of the fatigue crack growth.

Sichuan Union University, Chengdu

Contact: Prof. Xu Xi, Academician, Director, Polymer Research Institute and Director, State Key Laboratory of Polymer Materials Engineering
Chengdu, Sichuan 610065, PRC
Tel: 86-028-558-1554 Fax: 86-028-558-2670

- Applications of Water-Soluble Polymers in Packaging and Agriculture.
- Liquid Crystal Thermosets and Composites
- Bismaleimide Matrix for High-Performance Composite Manufactured by Resin Transfer Moulding
- High Performance Engineering Plastics Based on Poly(para-phenylene)
- Low Shrinkage and High Performance Material Fibre Reinforced Composites
- Polymer Crystallization Under High Pressure
- Molecular Design of Novel Polymer Compatibilizer--Theory and Application
- Design and Control of Morphology of High Performance Composites
- New Coloring Technology of Aluminum and its Alloys
- Thermal Sensitive Switch Made of Mn-Zn Ferrite
- PVC Oligomer for Plasticizing PVC
- Ionomer Toughened HDPE, PP, and PPO/PS
- Investigation of Phase Behavior and Applicability of Time-Temperature Superposition Principle for Xenoy Resin
- High Density Polyethylene Based Materials and its Application for Slurry Transportation
- Test Rig for Long-time Cracking of Polymers and its Application
- Foamed Polypropylene Boards and Profiles for Construction
- PMN-PFR Shutoff Agent at High Temperature and Salinity for Oil Filed Exploration and Exploitation
- PDR Oil Phase Drag Reducer
- Preparation of New Polymer Materials for Damping Vibration and Noise
- Metal-like Polycarbonate
- SK Super Absorbent Polymer
- Polymer Materials for Cable: polyphenylene oxide based communication cable; CQS 911-PE Insulation Material for Communication Cable; HDPE Sheathing Materials for Optical Cable; PP Insulation Mateiral for Communication Cable; Radiation Corsslinking Polyethylene; Silane-Crosslinking PE Insulator in Power Cable

East China University of Science and Technology, Shanghai

Contact: Xu Zhongde, Deputy Director of Institute of Polymer Science and Engineering
Shanghai 200237, PRC Tel: 86-21-477-6735 Fax: 86-21-477-6735

- Polymer electrolyte systems for batteries.

The work described by Dr. Fang Bin was previously published by him in Polymer Communications in 1991.

- Poly-3-alkylthiophenes

Dr. Fang Bin decribed research on these extensively studied electrically conducting organic polymers which is similar to those previously published papers by U.S. scientists Fred Wudl and Alan Heeger.

- Rigid-Rod Polymers

Prof. Pingping Wu described their ongoing studies on PBZT, poly-p-phenylene benzobisthiazole and the oxygen analog PBO. These are thermally, oxidatively and gydrolytically stable polymers which have been spun into high performance fibers. The team felt that collaboration with a number of U.S. academic groups would be beneficial to this effort.

Institute of Metal Research, ACS, Shenyang

Contact: Prof. Li Yiyi, Director, the Institute of Metal Research
72 Wenhua Road, Shenyang, PRC
Tel: 024-343533 Fax: 024-391320

- Processing of Alloy and Intermetallic Single Crystals and Bicrystals for Mechanical Properties Studies; Characterization of the Fatigue Properties of Such Materials, E.g., for Potential Aerospace Applications.
- Rare Earth Additions to Materials for Mechanical Applications or for Magnetic Purposes.
- Prosthetics Devices, Both Load-bearing (Hip and Knee Implant) and Heart-valve Devices.
- Hydrogen Storage Materials.

North-Eastern University, Shenyang

Contact: Prof. Wang Qiyi, Vice President, North-Eastern University
Shenyang 110006, PRC
Tel: 86-24-389-3000 Ext. 4117 Fax: 86-24-389-2454

- Hydrogen induced superrplasticity of Ti_3Al intermetallics
- Liquid-solid rolling bonding of metals to produce clad metal sheets or strips

One metal is in liquid state while the other is in the solid state when they are rolled together, the liquid metal is crystallized and forms a very strong bonded layer under rolling conditions.

- Super-magnetostriction materials and mechanism

Casting with electromagnetic stirring to produce small grain size, magnetic alloys with rare earth components

- Study on Phase transitions of high magnetic Induction Fe(Si)-N material system.
- Ceramic nanocomposites of Al_2O_3-SiC-YAG, Al_2O_3-Si_3N_4, MgO-SiC systems

Institute of Corrosion and Protection of Metals and Corrosion Science Laboratory, ACS Shenyang, Liaoning Province

Contacts: Prof. Wu Wei-Tao, Director of the Institute

- Rare-earth Containing Coatings, Specifically Involving Both Rare-earth Additions to Materials Such as Nickel Aluminides and in the Co-deposition of Rare-earths and Coatings.
- Molten Salt Corrosion for Carbonates for Fuel-cell Development
- Corrosion Control Techniques, Specifically in the Use of Cathodic Protection of Pipelines and Oil Rigs.
- Development of Corrosion Resistance in Steels for Reinforcing Concrete
- Laser Coating and Laser Welding Studies.

University of Science and Technology of China, Hefei, Anhui Province

Contact: Dr. Meng Guang-Yao, Director, Solid State Chemistry and Inorganic Membrane Lab. Department of Materials Science & Engineering, University of Science & Technology of China, 96 Jinzhai Rd., Defei, Anhui 230026, PRC
Tel: 86-551-360-3234 Fax: 86-551-363-1760

- Preparation of ultra-thin oxygen separation membranes
- Preparation of GaN and AlGaN crystal layers for UV/blue p-n junction diodes by plasma CVD processes
- Preparation of AlN layers by plasma CVD
- Preparation of tough ceramic membrane supports with large porosity and uniform pore size

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