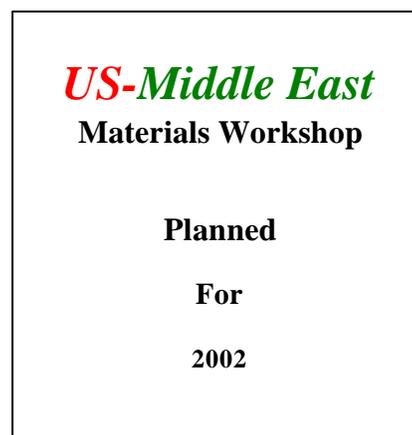
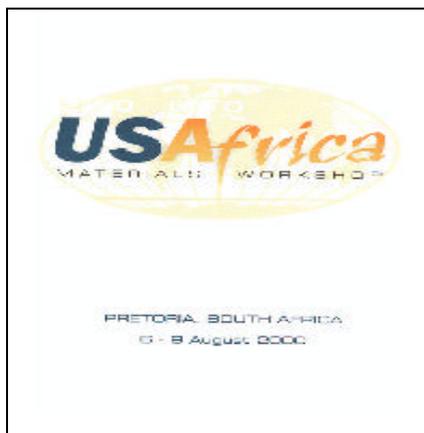
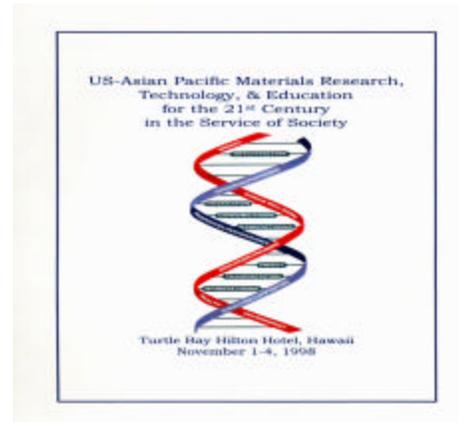
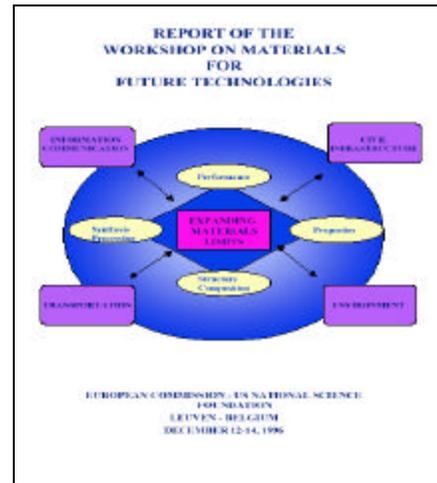
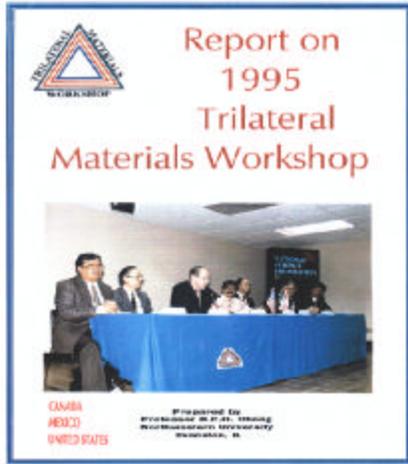


TOWARD AN INTERNATIONAL MATERIALS RESEARCH NETWORK

Status Report, January 2002



Background

Materials are more than mere components of modern tools - the basic properties of materials frequently define the capabilities, potential, reliability, and limitations of technology itself. Materials and processes will play an ever increasing role in improving energy efficiency, promoting environmental protection, lowering health-care costs, developing an information infrastructure, providing modern and reliable transportation and civil infrastructure systems, and strengthening security worldwide. Advances in materials science and engineering, therefore, enable progress across a broad range of scientific disciplines and technological areas with dramatic impacts on society.

Continued progress in materials science and engineering is increasingly dependent upon collaborative efforts among several different disciplines, as well as closer coordination among funding agencies and effective partnerships involving universities, industry, and national laboratories. Because of the interdependence of countries' national priorities, partnerships are not only important at the national level but from an international point of view as well.

With this in mind, the National Science Foundation has co-sponsored a series of five international workshops in materials research designed to stimulate enhanced collaboration among materials researchers and create networks linking the participating countries.

The first workshop, held in May 1995 in Saltillo, Mexico, involved scientists and engineers from the U.S., Canada, and Mexico. The workshop was organized by Dr. Leonel Cota Araiza, Instituto de Fisica, UNAM, Ensenada, Mexico; Prof. R.P.H. Chang, Northwestern University, Evanston, IL, USA; Dr. Manuel Mendez Nonell, CINVESTAV, Saltillo, Mexico; and Prof. Juan Sanchez, University of Texas, Austin, TX, USA, and was attended by 57 participants and observers from the three principal countries as well as Brazil, Chile, and Columbia. NSF was represented by William Harris, Adriaan de Graaf, Harold Stolberg, and Robert Wellek.

The second workshop, a joint National Science Foundation-European Commission venture, took place in December 1996 in Leuven, Belgium. The workshop was organized and chaired by Prof. Horst Czichos, President, BAM, Federal Institute for Materials Research and Testing, Berlin, Germany; Prof. Bertrand Escaig, Laboratoire de Structures et Proprietes de l'Etat Solide, Universite des Sciences et Technologies de Lille, France; Prof. Jean-Pierre Celis, Faculty of Applied Sciences, Catholic University, Leuven, Belgium; Dr. Praveen Chaudhari and Dr. Mark Ketchen, IBM T.J. Watson Research Center; Prof. Venkatesh Narayanamurti, Dean, Division of Engineering and Applied Sciences, Harvard University, Cambridge, MA, USA; and Dr. James Williams, Dean, College of Engineering, Ohio State University. The workshop was attended by 72 scientists and engineers from EU member states. NSF representatives included Adriaan de Graaf, Lance Haworth, Jeanne Hudson, John Hunt, John Hurt, Elbert Marsh, and Thomas Weber.

The third workshop, involving participants from the U.S. and Pan American countries including Brazil, Argentina, Chile, Uruguay, and Venezuela, took place in Rio de Janeiro, Brazil in June 1998. The workshop was organized by Dr. Miguel Blesa, Comision Nacional de Energia Atomica, Buenos Aires, Argentina; Prof. Guillermo Solorzano, PUC, Rio de Janeiro, Brazil; Prof. Edgar Zanotto, Universidade Federal de Sao Carlos, Brazil; Prof. Guillermo Gonzalez -Moraga, Universidad de Chile, Santiago, Chile; Prof. R.P.H. Chang, Northwestern University, USA, and Dr. Kathleen Taylor, General Motors, USA and was attended by 79 participants from Argentina, Brazil, Chile, the United States, and observers from Colombia, Honduras, Mexico, Uruguay, and Venezuela. The NSF was represented by Adriaan de Graaf, Robert Eisenstein, Raul Miranda, Harold Stolberg, Thomas Weber, and Robert Wellek.

The fourth workshop focused on the U.S. and Asian Pacific countries and was held in Hawaii in November 1998. The workshop was organized by Prof. Masao Doyama, Teikyo University of Science and Technology, Japan; Prof. Minhua Jiang, Shandong University, China, Prof. Hyeong Joon Kim, Seoul National University, Korea; Prof. Jim Williams, The Australian National University, Australia; Dr. Nikolai Lyakhov, Siberian Materials Research Association, Russia; Prof. Lih J. Chen, National Tsing Hua University, Taiwan; and Prof. R.P.H. Chang, Northwestern University, USA. The 81 participants and observers were from Australia, China, Japan, Korea, Malaysia, Singapore, Taiwan, the United States, and South Africa. NSF representatives included Adriaan de Graaf, Lance Haworth, Alice Hogan, George Strawn, Thomas Weber, and Robert Wellek.

A fifth workshop involving the U.S. and African countries took place in Pretoria, South Africa in August 2000. The workshop organizers were Prof. Ababacar Chedikh Beye, UCAD, Dakar, Senegal; Prof. Arthur Every, University of Witwatersrand, South Africa; Dr. Joseph Gogo, STEPRI, CSIR, Ghana; Prof. Kavishe, Moi University, Kenya, Nairobi, Kenya; Prof. Marjorie Mujaji, University of Zimbabwe, Zimbabwe; Prof. E.R. Sadiku (representing Nigeria), University of Stellenbosch, South Africa; Prof. Ron Sanderson, University of Stellenbosch, South Africa; Prof. Joseph Tesha, University of Dar es Salaam, Tanzania; Prof. A.J. Varkey, University of Swaziland, Kwaluseri, Swaziland; Prof. R.P.H. Chang, Northwestern University, USA; and Prof. Isiah Warner, Louisiana State University, USA. The number of participants and observers was 81 from Botswana, Egypt, Ethiopia, Ghana, Kenya, Lesotho, Morocco, Namibia, Nigeria, Senegal, South Africa, Swaziland, Tanzania, United States, Zambia, and Zimbabwe. NSF representatives included Joseph Bordogna, Adriaan de Graaf, Robert Eisenstein, Lance Haworth, Elbert Marsh, Wanda Ward, and Thomas Weber.

These workshops have involved close to 400 people from many countries, from government, from industry, and from universities. Their ideas, contributions, and support resulted in a set of high-quality workshop reports. The executive summaries of these reports are attached to this status report. The full reports of the workshops are available at <http://www.iumrs.org>.

The idea for the workshops was conceived by the author and by Prof. R.P.H. Chang, Director of the Northwestern University Materials Research Center. Prof. Chang, who was the co-organizer of and the brains behind 4 of the 5 workshops, i.e., those held in Saltillo, Rio de Janeiro, Hawaii, and Pretoria, received support from NSF for this activity. The Leuven workshop was organized directly by the NSF and the EC. NSF staff who played significant roles in making the workshops the successes they were, include Alex DeAngelis, Lance Haworth, Alice Hogan, Jeanne Hudson, John Hunt, John Hurt, Harold Stolberg, Pat Tsuchitani, Thomas Weber, and Robert Wellek. The encouragement by NSF Director Neal Lane during the initial stages of this effort and the constant support by NSF Deputy Director Joseph Bordogna and NSF Assistant Director for Mathematical and Physical Sciences Robert Eisenstein, have provided valuable stimuli to continue this important project, despite inevitable administrative and political obstacles. This effort has brought us closer to the ultimate goal of achieving an international materials network that facilitates the development of future technologies and provides future generations of young scientists and engineers throughout the world with greater opportunities.

Conclusions

The workshops identified possible areas for mutually beneficial collaborations. They also led to a number of major recommendations including:

1. Promoting *virtual institutes* via the internet with video capabilities for distance conferencing and learning;
2. Organizing and coordinating *exchange science and education programs* at all professional levels;
3. Developing a *materials world net* that will act as a resource for research and education (e.g., a searchable database containing materials properties, publications, facilities, instruments, experts);

4. Establishing *mechanisms for long-term collaborations* among academia, industrial, and government laboratories; and

5. Enhancing *public awareness* of the contributions of materials science and technology.

Ongoing and Future Activities

A sixth workshop involving Middle East countries is being explored. Lance Haworth and David Nelson from NSF visited counterpart funding agencies and materials research institutions in Egypt, Jordan, and Turkey in the fall of 2000, and Robert Eisenstein and David Nelson met with agency officials, researchers and educators in Israel in 2001. A planning meeting for the US-Middle East materials workshop is tentatively scheduled for 2002 in Ankara, Turkey.

As a result of the joint National Science Foundation-European Commission workshop, an implementing arrangement between the European Commission and the National Science Foundation for cooperative activities in the field of materials sciences is now in effect (see <http://www.nsf.gov/pubs/2000/nsf0018/nsf0018.htm>). The first awards were made in 2000 and 2001 following open competitions which involved coordinated review by the NSF and the EC. In two of the new collaborations, for example, inter-university US teams are partnering with multinational European research groups to fabricate novel nanostructured materials and to elucidate their behavior. A joint NSF-EC workshop to identify research opportunities in nanotechnology was held in Toulouse in October 2000; a series of four topical workshops in 'nano' planned for the US and Europe in 2002 will build on the findings of the Toulouse workshop.

Efforts to develop additional US-European interactions that complement and extend the NSF-EC cooperation are also bearing fruit. With the help of the NSF Office of International Science and Engineering, MPS staff organized a series of meetings with staff from European funding agencies beginning in 1998 to exchange information about national funding programs in materials, and to explore interest in supporting bilateral and multilateral research and education cooperation. The NSF is now preparing an announcement to the research community, better known as "Dear Colleague Letter" to initiate joint activities in cooperation with several European agencies including the Deutsche Forschungsgemeinschaft (DFG) in Germany; the Consiglio Nazionale delle Ricerche (CNR), the Consorzio Interuniversitario per la Scienza e la Tecnologia dei Materiali (INSTM), and L'istituto Nazionale per la Fisica della Materia (INFN) in Italy; the Swedish Foundation for Strategic Research; Science Foundation of Ireland; and others. A workshop to identify opportunities for US-Italy cooperation in materials and nanotechnology is planned for March 2002 at the NSF.

"Dear Colleague Letters" are also being prepared by science funding agencies in Canada, Mexico, Argentina, Brazil, and Chile, as well as by NSF to initiate joint activities involving scientists and engineers from these countries in response to the recommendations of the workshops held in Saltillo and in Rio de Janeiro.

In order to explore ways to implement the recommendations of the Pretoria workshop, a meeting of government officials from thirteen African countries and the NSF was held on August 13, 2001 in Nairobi, Kenya. The minutes of this meeting are attached. A second meeting of this kind will be held in Dakar, Senegal, in 2002.

With respect to Asian Pacific countries, implementation of the Hawaii workshop recommendations is being discussed with various science funding agencies in these countries. A meeting in Moscow is planned for 2002 to explore ways to enhance scientific collaborations between materials researchers in Russia and their counterparts in the US. The Russian Foundation for Basic Research will host this meeting. Similar meetings are expected to take place with agencies in other major Asian Pacific regions (e.g., Australia, China, India, Japan, Taiwan, Singapore, South Korea) over the next few years.

The NSF is preparing an "International Materials Institutes (IMIs)" competition in early CY 2002. It is expected that this competition will lead to the establishment of up to 3 IMIs that would address

recommendations 1-5 mentioned above, serving as the initial US nodes of a world-wide network for international cooperation in materials research and education. This is a joint activity involving several directorates, including Engineering; Computer and Information Science and Engineering; Social, Behavioral, and Economic Sciences (Office of International Science Engineering); and Mathematical and Physical Sciences.

The countries mentioned in this report that contributed to the organization of the workshops will form the core of the envisioned world-wide materials network. Countries that sent observers to the workshops or those that were not represented may, of course, join the network at any time by forming partnerships with appropriate government and private organizations in other countries and issuing their own announcements to their respective research communities.

The materials network, once it is fully operational in a few years, should serve as an example for the other sciences and engineering fields to follow. We believe that international networks connecting scientists and engineers around the world are increasingly important as the new millennium unfolds, and as the demands of economic and global security test our scientific, engineering and technological capabilities more than ever.

Adriaan de Graaf
Directorate for Mathematical and Physical Sciences
National Science Foundation

January 2002