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FINAL REPORT

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NANO 2002**

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**The Sixth International Conference on Nanostructured Materials
NANO 2002**

**Orlando, Florida
June 16-21, 2002**

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Prof. Enrique Lavernia (co-chairman), University of California-Irvine
Dr. Michel L. Trudeau (co-chairman), Hydro Quebec

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Introduction

The Sixth International Conference on Nanostructured Materials (NANO 2002) was held in Orlando, Florida, June 16-21, 2002. It was the latest in a series of international conferences on nanostructured materials held, for the first time, in the United States. Previous meetings were held in Cancun, Mexico (1992), Stuttgart, Germany (1994), Kona, Hawaii (1996), Stockholm, Sweden (1998), and Sendai, Japan (2000). The next conference in this series is slated for June 2004 in Wiesbaden, Germany.

Statistics

The five-day conference ran from Sunday through Friday and was attended by approximately 400 researchers, scientists, students, and government officials representing Australia, China, Taiwan, Japan, So. Korea, India, Singapore, United States, Canada, Mexico, Venezuela, Russia, Switzerland, Sweden, Great Britain, France, Portugal, Italy, Greece, Germany, Colombia, Bulgaria, and Poland. It provided a forum for the exchange of information on the latest developments and new trends in the growing field of nanoscience and technology.

It addressed critical scientific issues related to theory, computational modeling, synthesis, processing, characterization, properties, and performance of nanostructured materials, and their fabrication into useful structures, devices, and engineered systems. All classes of materials were included, including structural, functional, and specialty materials for diverse applications. Special emphasis was given to aspects of nanotechnology, such as MEMS, sensors, and other microengineered structures.

General topical areas and categories included:

1. Theoretical modeling and computer simulations of nanostructures and properties
2. Synthesis and processing—thin films and layers
3. Synthesis and processing—solidification technique
4. Synthesis and processing—mechanical methods
5. Synthesis and processing—nanocrystallization of amorphous alloys
6. Synthesis and processing—electrodeposition, other physical, chemical, and biological methods
7. Nanocomposite (metal-metal, metal-ceramic, biocomposites)
8. Structure and characterization
9. Crystallography of nanocrystalline and nanoquasicrystalline material
10. Clusters and cluster assembled material
11. Mechanical properties and deformation behavior
12. Magnetic properties
13. Electrical and optical properties
14. Designing properties by microstructural control
15. Thermal stability and phase transformations in nanomaterials
16. Performance and applications
17. MEMS, sensors, and other microengineered structures
18. Bulk nanostructured materials

The scientific program was divided into parallel oral and poster sessions covering the following topics:

Coatings
Thin Films and Multilayers
Fullerenes and Nanotubes
Optical and Electronic Materials
Processing
Structure and Properties
Optical and Electronic Materials
Magnetic Materials
Surface Phenomena
Catalysis and Energy Related Materials
Thermal Stability and Phase Transformations
Biomaterials
Particles and Clusters

Highlights

Some high points of the conference included keynote addresses by prominent leaders in the field, a sampling of which is listed below:

- “Nanotechnology: It Will Improve Our Way of Life—Will It Improve our Politics?” by Merrilea Mayo, Director, Government-University-Industry-Research Roundtables, The National Academies, Washington, DC
- “Engineering and Assembly of Nanoparticles for Advanced 2-D and 3-D Structures,” by Mamoun Muhammed, Royal Institute of Technology, Stockholm, Sweden
- “NanoMechanical Technology: Recent Progress, Challenges, and Opportunities,” by Subra Suresh, Massachusetts Institute of Technology, Cambridge MA, USA
- “Applications and Markets for Nanotechnology Products,” by Mathias Werner, Microtechnology Innovation Team, Deutsche Bank AG, Germany
- “Nanomaterials Initiative 2002 of MEXT in Japan,” by Kazuo Furuya, National Institute for Material Science, Japan

Financials

Over \$80,000 was provided by various sponsors in support of the conference. Of that amount, the Air Force Office of Scientific Research provided \$6,000 in assistance for participants and general conference support. The assistance took many forms, depending on individual needs. In most cases the registration fee was either waived or reduced, primarily for graduate students, post-docs, and researchers. We also negotiated reduced room rates for young faculty and students, which was arranged with the hotel management. It should be noted that, because of the impact of 9/11, and the inevitable reduction in attendance, this presented us with considerable difficulties with hotel management. However, it was not a surprise to them because they had had similar experiences with meetings before our meeting; in fact, some were canceled outright.

Conference Proceedings

All manuscripts were submitted at the time of registration and screened for content. After review and corrections, about 200 papers were accepted for publication. As advertised, it was the intention of the Publications Committee to incorporate the proceedings into a CD. This was a new experience for the committee and has encountered numerous difficulties, largely of a technical nature. However, these now seem to have been overcome and copies will be mailed to all registrants, as well as to the supporting funding agencies.

Participation of Young Faculty and Students

This meeting was the first of its kind where young faculty and their post-docs and graduate students held center stage. This was by design because the Program Committee felt that it was this new generation of researchers who will be making the difference in the long run. Moreover, they would benefit most from the scientific interchanges with colleagues, not only in the US, but around the world. In fact, the feedback that we have received in this office is that this objective was more than met. Numerous interactions have developed, particularly in exciting areas such as self-assembly, photonic and magnetic materials, biomaterials, and fullerenes /carbon nanotubes. Two new Assistant Professors in this department, for example, have already established collaborations with their counterparts in Europe.

At every occasion, the Program Committee was careful to ensure that the younger faculty got prominent exposure. In a few cases, young professors actually gave opening talks in specialty sessions, usually reserved for mature faculty. This was certainly appreciated by the younger contingent, who welcomed the opportunity to gain the kind of exposure that such a prestigious meeting guarantees. It is to their credit that the presentations were outstanding and the illustrations exceptional. The only group that didn't measure up to the high standards expected of invited speakers were those from Mainland China, and that was largely due to language problems, and not having the resources (yet) to give a polished PowerPoint presentation.

A major effort was made by the Program Committee to encourage participation of women and other minorities in the engineering profession. Looking at the enrollment, it is clear that about 10% were women and minorities, including participants from the US, Europe, and Asia. One disappointment was the shortfall in registration from Mainland China, although they had pre-registered and submitted papers. This was because of the impact of 9/11 on visa applications. In fact, the meeting suffered from a lot of unexpected last minute cancellations for this reason. Incidentally, our meeting was not the only one to be affected by the tragedy of 9/11. Some meetings had to be canceled altogether. Nevertheless, we did have an attendance of almost 400, including many from abroad, after appeals to their respective embassies for special visa clearance.

Another important development has been the recognition that the time is at hand to make linkages between bioengineering and nanotechnology. This is being done within all academic institutions today, and most of them have already established or are about to establish new engineering divisions within Schools of Engineering. For example, here at Rutgers University, we have founded a new department of Biomedical Engineering. Some of the staff have joint appointments with our the Dept. of Materials Engineering in order to develop cooperative programs that everyone sees as having great potential for the future.

International Exchange of Information

Dr. Merrilea Mayo, Director Government-Industry-Research Roundtables, National Academies, set the tone for the meeting with an inspiring lecture. She is now one of the leading advocates for Nanoscience and Technology in the federal government and continues to lend her support to the current NSF-led initiative. As she explained, she has participated in numerous studies on this topic for diverse interests within the federal government, including those of DoD, DoE, NIH, and EPA. Apart from the exciting vista that she painted for future applications in nanotechnologies, a sobering thought was her recognition of health hazards that need to be addressed and overcome, particularly when dealing with processing and handling of nanoparticles.

Following this talk, Prof. Muhammed, the Royal Institute of Technology, gave us a glimpse of the exciting developments in nanotechnology in Sweden. It came as a great surprise to us all to learn of the *major* commitment made by the Swedish government to this field and the substantial resources already allocated to academic research institutions to conduct frontier research, similar to that supported by NSF in this country. Then we heard from Dr. Furuya, National Institute for Materials Science in Japan, who, as you might expect, clearly demonstrated that the Japanese government has made a commitment comparable to that of the US. In fact, when measured on a per capita basis, the investment exceeds that of the US. The view with respect to the European economic Union was described by Dr. Matthias Werner, Director of the Microtechnology Innovation in Germany. Although some of the earliest and most critical innovations in the synthesis of nanomaterials were made in Germany, it was a surprise to learn that they had not got their act together yet in Brussels, but were working on it. Once they get things sorted out, there is no doubt that they will be formidable competitors in the global competition to develop applications for nanotechnologies, in which today Japan and the US seem to hold a leadership position. Unfortunately, we did not hear from Mainland China because the designated speaker was unable to obtain a visa. However, some of his colleagues at the meeting indicated that China had already established five major fields for investment, and nanotechnology was one of them. Overall, therefore, the conferees felt they were well served by the selected group of invited speakers from key areas around the world.

In the ensuing technical presentations, the diversity of topics far exceeded anything covered in the previous five international conferences. It is simply extraordinary how diversified the field has become over the last few years, with no end in sight. It is this writer's impression that the global study on nanoscience and technology conducted a few years ago under the leadership of NSF has been accepted by the nations across the world and they have formulated their own strategic plans, largely based on input from that impressive study.