

## **Recommendations of the Fourth U.S.-Korea Forum on Nanotechnology: Sustainable Energy**

*Adopted on April 27, 2007*

During the past five years, Korea and the United States have been supporting nanotechnology as a priority research area. The delegates at the 5th meeting of the Korea-U.S. Joint Committee on Scientific and Technological Cooperation (held on October 30<sup>th</sup> & 31<sup>st</sup>, 2002 in Seoul, Korea) agreed that establishment of a Korea-U.S. Forum on Nanotechnology would be beneficial to promote and enhance research collaborations in the field of nanotechnology among scientists and engineers from both countries. Specifically, a joint Forum between Korea and the U.S. will facilitate networking between the research communities and agencies of both countries, enabling each side to exchange information and explore opportunities for cooperative efforts. With this mission, we organized the first Korea-U.S. Forum on Nanotechnology, via National Science Foundation (NSF) funding, at Seoul, Korea on October 14-18<sup>th</sup>, 2003. As the Korean counterpart to NSF, participation was overseen and funded by the Korean Ministry of Science and Technology (MOST). The first Forum was attended by 250 participants from both the countries and covered a broad range of nano-research areas. The second forum, held in Los Angeles on February 17-19<sup>th</sup>, 2005, was a topical meeting focused on nano-manufacturing and educational program development on nanotechnology. The Forum was attended by 32 experts in these areas. The third forum, held in Seoul on April 3<sup>rd</sup> & 4<sup>th</sup>, 2006, was focused on two areas: (i) active devices and systems research in nanotechnology, and (ii) health, environmental, and safety implications on nanotechnology. The focus on active devices is a distinction from passive systems which were included in the previous two Forums. In contrast to passive structures, the active nanostructure changes its state during its operation, as in nanoparticles and nanotube/wire. This forum was attended by 150 participants from both countries.

This fourth forum focused on sustainable nanotechnology- energy dealing with the design, synthesis, fabrication, and characterization of nano-materials as well as devices and system for energy applications such as fuel cells, batteries, hydrogen storage & production, and solar cells. The forum was held in Honolulu, Hawaii on April 26<sup>th</sup> and 27<sup>th</sup> 2007, and attended by 36 experts in energy related area.

The following are the recommendations of this forum to ensure the partnership between these two countries for the continued success of nanotechnology-energy research, which could enable the production of cost-effective sources of energy and accelerate the transition towards clean, sustainable, and renewable energy resources that could complement current fossil energy resources.

- (1) We will continuously provide a common platform for the researchers in both countries to share experiences and expertise and enhance partnership in the field of nanotechnology. We recommend facilitating interactions between program managers of the areas of interest to the forum.
- (2) We recommend holding annual forums for increasing the bi-lateral exchanges in number of graduate students, post doctoral fellows, and young investigators.
- (3) Both NSF and MOST should provide a mechanism to allocate steady funding for the forum to continue this forum annually as well as collaborations between U.S. and Korean Institutions.
- (4) We encourage more industrial participations and under-represented groups at the forum.
- (5) Energy is a common global problem. Energy technology fused with nano-technology could help overcome the current obstacles in fossil energy. Both countries should promote this research area and enhance their collaborations.
- (6) We recommend to create website dedicated to US-Korea exchange program and designate contact personnel from each country to identify possible sources for financial support and to exchange technical information.

The specific recommendations on the two groups are listed below:

#### Group I (Solar Cells)

Support and encourage material and device research for third generation photovoltaic research

- (Tandem) dye sensitized solar cells
- QD solar cells & multi exciton generation
- Organic PV: molecular order and morphology
- Experiments and correlated theory for charge transfer, injection, and transport
- Theoretical understanding of electrons and phonons in nanomaterials
- Development and application of cutting-edge nano characterization tools
- . Development of advanced transparent conducting oxides for next generation PV devices and electronics
- . Doping of QDs
- . New material design – new organic molecules and dye molecules
- . Increase emphasis on the computational discovery of new nanomaterials
- . Theoretical understanding of mesoscopic scale phenomena

Other recommendations:

- . We need a strong leadership to pursue nano program for energy.

## Group II (Hydrogen Storage, Secondary Batteries, Fuel Cell etc.)

### 1) Hydrogen Production and Storage

- Band structure engineering for semiconductors for photocatalytic water splitting
- Synthesis of semiconductor materials with better size and structure control for photocatalytic water splitting
- New hydrogen storage materials through nano/meso-structural engineering
- Control of hydrogen storage and release kinetics through nanoscale materials

### 2) Secondary Batteries

- Include supercapacitors in the Forum discussions
- Nano-sized, nano-coated, and nano-structured materials for both batteries and supercapacitors
- Design and processing of thin film and flexible batteries and supercapacitors
- Design of three dimensional batteries and supercapacitors
- Safety issues related to nano-materials and nano-devices

### 3) Fuel Cells

- In view of the increasing activity on fuel cells in both Korea and U.S., hold a separate bilateral workshop just on fuel cells, with participation of academia, national labs and industry.

#### A) Fuel Cells – PEM

- Fundamental understanding of catalysis and transport on nanoscale
- Highly catalytically active and stable electrodes for PEM fuel cells
- High performance PEM fuel cells through use of nanostructured electrode/electrolyte interfaces
- Reduction in Pt loading and non-noble metal catalysts for PEM fuel cells through use of nanostructured electrodes
- Nanocomposite electrolyte membranes

#### B) Fuel Cell - Biological

- Small-size satellite workshop on different types of bio-fuel cells for better understanding and education
- Increase participation of researchers in different bio-fuel cell areas
- Nano-biocatalysis and nano-engineering for improved lifetime and power output of bio-fuel cells (including characterization techniques)

#### C) Fuel Cells – SOFCs

- Reduction of cell operation temperature to allow utilization of high performance nanoscale materials and to reduce the overall cost

- Nano/microstructural engineering of the electrodes to improve the long term stability of nanoscale materials
- Better understanding of the ionic transport on nanometer scale

| <b>On behalf of the U.S participants</b>                                               | <b>On behalf of the Korean participants</b>                             |
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| <b>Myung S. Jhon, Professor<br/>Carnegie Mellon University<br/>Pittsburgh, PA, USA</b> | <b>Jo-Won Lee, Director<br/>Tera-level Nanodevices<br/>Seoul, Korea</b> |