BES Workshop Illuminates the Future of Lighting Research

After intense discussions, a group of leading researchers has converged on two grand challenges for basic research in solid-state lighting: the rational design of solid-state lighting systems, and a detailed understanding of the radiative and non-radiative pathways of charge carriers in semiconductors. The group identified these challenges at a workshop held in May in Washington D.C., sponsored by the U.S. Department of Energy's Office of Science, Basic Energy Sciences (BES). Participants say that meeting these two challenges will make it possible for solid-state lighting to become a widespread competitor of incandescent and fluorescent lighting.

With the advent of the nanoscience revolution, new opportunities are available that can make light-emitting diodes (LEDs) a competitive lighting solution for a broader range of applications, according to Jim Misewich of Brookhaven National Laboratory, who participated in the workshop. In particular, Misewich said, further basic research will enable precise tuning of the optical and transport properties of semiconductors and lead to higher-quality materials and more precise placement capabilities. In addition, it will give researchers a better theoretical understanding of how to optimize all of these factors and create more efficient lighting systems.

The second grand challenge, a detailed understanding of the pathways of charge carriers, is also within reach, thanks to advances in nanoscience, reported Jerry Simmons of Sandia National Laboratories. Simmons and the other workshop participants are optimistic that an increased understanding of materials on the nanoscale will lead to new methods for controlling radiative and non-radiative recombination in semiconductors. This control would facilitate LEDs with increased optical efficiency and dramatically enhance the amount of light they emit, he said.

In addition to these two grand challenges, workshop participants identified 12 priority research directions (PRDs) for solid-state lighting, many of which are stepping stones to the two grand challenges. The PRDs include basic research goals such as determining what limits the light emission in InGaN, managing and exploiting disorder in organic LEDs, and achieving precise nanoscale characterization of materials for solid-state lighting.

The Workshop on Basic Research Needs for Solid-State Lighting was the fourth in a series of workshops held by BES. The workshops aim to identify areas where more basic research could help ensure a secure energy future for the world, according to Patricia Dehmer, associate director of science for BES. Participants are "the best researchers from the U.S. and abroad," she said, "and we give them free rein to discuss the basic research needs for both short-term and long-term impacts."

Each workshop produces a detailed report that is appropriate for audiences ranging from policymakers to the scientific community. Previous reports have been looked upon favorably by policymakers, according to Dehmer, and align well with President Bush's Hydrogen Fuel Initiative, American Competitiveness Initiative, and Advanced Energy Initiative.

In the few years since the workshop and publication of *Basic Research Needs for the Hydrogen Economy* (2003), the budget for hydrogen-related basic research has risen from $7 million to $50 million as proposed in the president's request for FY2007. Similarly, the budget request for basic solar energy research has seen an increase of close to $35 million for FY2007, much of this aimed at research suggested by the *Basic Research Needs for Solar Energy Utilization* report (2005). The results of the lighting workshop held in May are likewise expected to set the tone for basic solid-state lighting research funding in coming years.

More than 50 experts in solid-state lighting and related research areas from university, national, and industry laboratories participated in the workshop in May. Workshop co-chair Paul Burrows of Pacific Northwest National Laboratory opened the workshop by challenging the group to identify the research needs of LED technology. He encouraged the attendees to focus on challenges that have the potential to make a significant long-term impact on the efficiency and practicality of solid-state lighting.

Participants were assigned to one of three panels based on their research area: LED science, organic LED science, or cross-cutting and novel materials science and optical physics. Each panel discussed the fundamental scientific challenges in their field and identified a few PRDs. Panel chairs then synthesized the discussions and honed in on the two grand challenges.

"The result," said workshop co-chair Julia Phillips of Sandia National Laboratories, "is a set of scientific challenges that not only have the potential to have significant impact on the future of solid-state lighting but also probe some of the frontiers in science that are fascinating in their own right."

The *Basic Research Needs for Solid-State Lighting* report will be available in mid-August on the BES Web site, http://www.sc.doe.gov/bes/. Reports from past workshops are also available on this site.

KENDRA RAND

Academy of Finland and Tekes Foresight Project Identifies Key Priorities for the Future

Members of FinnSight 2015, a joint project of the Academy of Finland and Tekes, the Finnish Funding Agency for Technology and Innovation, have identified focus areas in science, technology, business and industry, and society for Finland. The project was organized into 10 panels with themes including materials, environment and energy, and the global economy. In all, the panels identified about 80 areas of expertise that Finland should focus on in order to reach scientific and technological breakthroughs and new innovations.

In the area of materials, the panel—chaired by Hilkka Knuuttila of Borealis Polymers Oy and the University of Joensuu and Päivi Törmä of the University of Jyväskylän—explored new application areas for developed materials. The FinnSight 2015 materials panel said that major scientific and technological achievements in materials development can be expected from interdisciplinary cooperation between the natural sciences and technology fields.

Among the focus areas identified by the materials panel were surface engineering techniques and printed electronics as well as specialized and effective utilization of wood and biomass. Technology transfer is a separate competence area that ties in with the development of all other innovation chains, the panel said. Technology transfer should be improved by developing funding structures, intensifying cooperation throughout the network of participants, and providing training to technology transfer professionals, according to the panel. In materials production as a whole, the panel identified a need to invest in modeling, particularly in the seamless cooperation between modeling and manufacturing.

The panel anticipates breakthroughs in smart and functional materials. Printed electronics combines the expertise and assets of Finland's strongest industries—electronics and paper—and stands to gain significant market position in a variety of applications, including packaging for commodity products, product specifications, and electronic displays, according to the panel.

Surface technology and surface treatments are rapidly gaining in significance, the panel said. Over the next 10 years,

major advances are expected in the development of soil-resistant, self-lubricating, antibacterial, and smart surfaces, for example. New surface techniques will offer improved product characteristics or even entirely new product functions, such as material responses to temperature changes, the panel said. The materials panel set high expectations on nanotechnology.

According to the panel, the development of self-healing surfaces is expected to open new horizons on life-cycle thinking. Materials are expected to not only feature new characteristics, but also be environmentally friendly, recyclable, and help to conserve resources, said the panel.

New carbon and biomaterials represent a very interesting potential area of expertise. According to the panel experts, one way in which Finland could benefit from the development of these fields is through the search for new market niches.

It is too late for Finland to mount a large-scale basic research program on carbon materials, according to the panel, but it is nonetheless important to keep a close eye on developments in the field and to make carefully targeted research investments. Multidisciplinarity and biodegradability are two key aspects of the development of biomaterials. Another new field of research identified by the panel is that of biomimetic materials.

FinnSight 2015 identified environmental management as a new strength area for Finland. Faced with climate change and a scarcity of raw materials, the world needs to find and develop innovative environmental and energy solutions. The world's water supply is also in need of development, said the experts of the foresight project. Energy efficiency, in the experts' view, should be adopted as a foundation for Finnish competitiveness. The environment and energy panel was chaired by Allan Johansson of VTT and Harri Turpeinen of Neste Oil.

Growing challenges and new markets are emerging for sustainable-development products, particularly for urban environments and water purification systems. Work is already underway in China to design "ecocities," and Europe already has "ecodistricts" within some of its cities. A competitive advantage in building construction is being gained through an integrated approach to community planning, energy and waste management, transportation, logistics, public safety, and environmental quality, according to the environment and energy panel.

The panel said that renewable energy sources are rapidly gaining ground in the energy sector. Given Finland's abundant forest resources, the country is well positioned to use biomass as an energy source; the forest industry is already using biofuels, said the panel. The panel said that botany and plant breeding as well as genetic engineering should be harnessed for the development of biofuel production.

According to the panel, investment in smaller, decentralized energy solutions is increasing faster than investment in major power plants. For instance, applications in the 10–20 kW range are attracting considerable interest. Other promising areas include fuel cells and solar-generated heat and electricity, which are some of the fastest-growing forms of decentralized energy production.

The results of the various panel studies for FinnSight 2015 are reported in a summary that will be available in English by the end of August at Web site www.finnsight2015.fi.

Scientific Advisory Board Set Up to Advise NRF in Singapore

The Scientific Advisory Board of the National Research Foundation (NRF) in Singapore held its first meeting in April. The board, consisting of 15 distinguished scientists, researchers, and entrepreneurs from around the world, was established to advise the NRF on critical issues and emerging global trends in basic and investigator-led research where Singapore can play a significant role. The advisory board will help identify and recommend new areas of research in which Singapore can compete effectively and reap the benefits of cutting-edge science. The board will also assist and advise the NRF on the management of research and development, including processes to allocate funding and assess research outcomes, as well as review and comment on plans and proposals prepared by the NRF. Currently, the NRF has identified environmental and water technologies as two strategic areas of focus.

The Scientific Advisory Board is cochaired by Curtis R. Carlson, president and CEO of Stanford Research Institute International, and Ulrich W. Suter, a professor of polymer materials at the Swiss Federal Institute of Technology in Zurich (ETH Zurich). Carlson helped found more than 12 companies and has served on many U.S. government task forces. Suter was the vice president of research at ETH Zurich from 2001 to 2005. He had previously advised Singapore on matters of education and research.

The members of the advisory board have been appointed for the period of April 1, 2006, to March 31, 2009. They are expected to meet twice a year. □

ESF Announces Call for Proposals for Research Networking Programmes

The European Science Foundation (ESF) has launched a Research Networking Programme that brings together nationally funded research activities for four to five years, to address a major scientific issue or a science-driven topic of research infrastructure, at the European level with the aim of advancing the frontiers of science. Key objectives include:

- creating interdisciplinary forums;
- sharing knowledge and expertise;
- developing new techniques; and
- training young scientists.

A successful Programme proposal must show high scientific quality and also demonstrate added value by being carried out at a European level rather than by individual research groups at the national level.

Proposals may be submitted in any or across several broad scientific fields, including physical and engineering sciences. A Programme can include the following activities:

- Science meetings (workshops, conferences, or schools) organized either by Programme participants or following an open call for proposals;
- Grants for short and exchange visits awarded following an open call for applications;
- Publication of information brochures and leaflets, DVDs and CD Roms, scientific books and meeting proceedings, creation of Web sites; and
- Creation of scientific databases at the European level.

The deadline for proposals is October 30, 2006. More information is available at Web site http://www.esf.org/programmes/call/.