

### **NAS Highlights Potential of Biomolecular Materials Research**

The ability to replicate the complex functions carried out by biological systems in materials could have a profound effect on the quality of human life, according to a recently released National Academies report. Such developments would likely lead to major advances in alternative and renewable energy, health and medicine, and national security. But according to the report, such results require an interagency commitment to and an educational institution investment in programs at the intersection of the physical, life, and engineering sciences.

According to Arup K. Chakraborty, chair of the committee that authored the report, advances in biomolecular materials research are likely to pay off in both economic and societal terms. Investments in research programs and tools aimed at understanding biological systems on a fundamental level, and then harnessing this understanding to create synthetic systems, could lead to new materials with enormous potential for impact on national priorities ranging from reducing

dependence on oil to targeted drug delivery systems, the report said.

The committee presented the following recommendations for facilitating a better understanding of how biological systems function and turning this knowledge into tangible results.

- The Office of Science and Technology Policy should lead an effort to develop interagency programs that support innovative research at the intersection of disciplines in a concerted way. These programs should include incentives for universities to work across the traditional boundaries of disciplines.
- Universities and medical schools should ensure that their curriculum prepares students to work across the physical science, engineering, and life science disciplines. These educational programs should be evaluated and include input from leaders in industry and national laboratories.
- Relevant agencies such as the Department of Energy (DOE), National Institutes of Health (NIH), and National Science Foundation (NSF) should sup-

port the development of short courses aimed at enhancing communication between physical and life scientists and helping them identify cross-disciplinary research opportunities.

- Relevant agencies such as DOE, NIH, and NSF should intentionally build bridges from fundamental research results to commercial applications, and also encourage curiosity-driven fundamental research that could result in unanticipated applications.
- DOE should continue evaluating the effectiveness of its mid-range instrumentation and computations facilities for nanoscience and technology. Similar centers could be created for biomolecular materials and processes research.

The report also calls for a continued investment in biomolecular probes. "The exciting state of research in biomolecular processes and materials has been powered by new experimental and computational tools for interrogating complex systems at a high level of details," said the authors; "Further advances in the development and

application of these tools are crucial to the advancement of the field."

The committee highlighted the need for advances in the following categories of tools:

- experimental probes capable of revealing the molecular details and dynamics of biological systems, such as improved single molecule imaging technologies, electron microscopy, and x-ray and neutron scattering systems;
- theoretical and computational probes that take into account the complexities of biomolecular materials, such as a fundamental theory of systems far from equilibrium and multiscale simulations of biomolecular assemblies; and
- techniques for synthesizing, modifying, and manipulating novel macromolecules with atomic-level control.

According to the committee, developments in these three areas have great potential for advancing the field, especially when the technologies and tools are used to compliment one another.

Recent developments in the tools and techniques of multiple disciplines, such as the fluorescent labeling of molecules, advances in genetics, and computational and theoretical studies of biological systems and biomaterials have enabled people to observe and elucidate some of the underlying mechanisms behind how biomolecular systems and biomaterials function. This newly acquired knowledge was a major motivation for the report, as it makes this a very special time for this field at the intersection of disciplines, according to Chakraborty. Federal funding agencies such as DOE and NSF are planning to invest in the promising opportunities it has brought forward, he said, and the report will provide guidance for them as they work to prioritize investments.

The Committee on Biomolecular Materials and Processes, which authored the report, was convened by the National Research Council of the National Academies to assess current work and future promise at the intersection of biology and materials science. The committee was composed of experts from many fields of biomolecular materials research and spent two years compiling the report.

The report, *Inspired by Biology: From Molecules to Materials to Machines*, can be downloaded from the National Academies Press Web site, [www.nap.org](http://www.nap.org). It is intended to give program managers, scientists, students, and policy makers a sense of the type, scope, and potential impacts of biomolecular research opportunities.

KENDRA RAND

### NNI Sets R&D Priorities

The National Nanotechnology Initiative (NNI) recently updated its strategic plan for nanotechnology research and development (R&D) in the United States. The plan is in line with the current course of nanotechnology R&D and gives great emphasis to its value for society. It includes a number of high-impact opportunities and critical research needs related to nanotechnology, and sets the priorities of the federal funding agencies engaged in nanotechnology R&D.

The NNI establishes shared goals and priorities for nanotechnology R&D and coordinates efforts for the 25 participating federal agencies. Thirteen of the agencies in the NNI have a budget for nanotechnology R&D, such as the Department of Energy and the National Science Foundation, and others are involved in regulations and oversight. The new strategic plan will guide nanotechnology initiatives for the next three years.

NNI-supported activities are organized according to the following eight subject areas:

- Fundamental nanoscale phenomena and processes
- Nanomaterials
- Nanoscale devices and systems
- Instrumentation research, metrology, and standards
- Nanomanufacturing
- Research facilities and instrumentation acquisition
- Environment, health, and safety
- Education and societal dimensions.

The strategic plan outlines general priorities and action items for the nanotechnology community that cut across these subject areas. They are centered around the following four goals of the Initiative.

*Goal 1: Advance a world-class nanotechnology R&D program.* In order to stay on the cutting edge of nanotechnology R&D, the NNI will sponsor workshops on cross-cutting topics such as nanoelectronics and the transport of charge within nanomaterials. In addition to members of the research and industry communities, representatives from the budget and legislative affairs offices of various NNI agencies will be invited to the workshops so they can discuss possible collaborations. The NNI will also encourage collaborations between the scientists of different agencies.

*Goal 2: Foster the transfer of new technologies into products for commercial and public benefit.* The NNI can address this process from many sides since its members include basic research funding agencies and regulatory agencies. NNI plans

include giving small businesses and start-ups access to NNI-supported research results. In addition, it will continue working with the industry sector to identify research priorities and develop an international trade environment favorable to nanotechnology-based products.

*Goal 3: Develop and sustain the educational resources, workforce, infrastructure, and tools needed to advance nanotechnology.* Partnerships between industry, educators, and the federal R&D system are encouraged within the plan. It calls for continued support of ongoing education efforts, such as nanotechnology curriculum development, and for new career-based training efforts. Over the next few years the NNI will inventory the tools, facilities, and services available to users at NNI-funded centers and disseminate the database to potential users. Another priority is creating lines of communication between the centers, networks, and facilities so that they can share best practices.

*Goal 4: Support responsible development of nanotechnology.* The plan calls for potential environmental, health, and safety implications to be addressed by an iterative process of comprehensive planning, research coordination, and periodic review of the research needs and directions. In conjunction with this, the NNI supports research aimed at better understanding of the societal ramifications of nanotechnology and public education efforts.

A number of high-impact application opportunities and critical research needs for society that are likely to benefit from nanotechnology are highlighted in the plan, such as nanometer-scale materials fabrication, nanotechnology-enabled logic switches, and light-weight, strong materials that enable vehicles to run on less fuel than currently necessary. These areas represent the visionary, yet realistic capabilities of a commitment to nanotechnology R&D, according to the plan.

The less-than-expected fiscal year 2008 appropriations for many funding agencies will have a negative impact on nanotechnology activities, especially for the Department of Energy Office of Science, the National Science Foundation, and the National Institute of Standards and Technology. The President's 2009 budget proposal, however, includes a significant increase for NNI-related activities and strong support for nanotechnology R&D in Congress remains.

"There is still great enthusiasm for the kinds of new advances that nanotechnology is bringing," according to Dr. Altaf Carim, co-chair of the Nanoscale Science, Engineering and Technology Subcommittee of the National Science and

Technology Council, which released the plan. "There are more and more indications of new developments and things moving from the lab into the marketplace. There are a lot of exciting developments both in the fundamental areas and the applications that are being learned."

The NNI was formally established in 2001. In 2003, the 21st Century Nanotechnology Research and Development Act formalized the structure and reporting requirements of the initiative and authorized federal funding of NNI-supported efforts for fiscal years 2004–2008. Funding is set by yearly appropriations and is not dependent on an authorization bill; however, a re-authorization of the act could change or extend the parameters of the initiative. According to Carim, a number of congressional offices have shown interest in re-authorizing the bill and discussions are underway.

This plan replaces the first strategic plan, released in 2004. The 2007 plan was compiled with input from the 25 participating agencies, reviews of the NNI by the President's Council of Advisors on Science and Technology and the National Research Council of the National Academies, and topical workshops involving experts from academia, government, and industry. It is available on the NNI Web site, [www.nano.gov](http://www.nano.gov).

KENDRA RAND

### Environment Ministers from EU, Latin America, and Caribbean Countries Meet in Brussels

Climate change adaptation, renewable energy, biodiversity loss, and deforesta-

tion were at the top of the agenda of the first meeting between the European Union (EU) and Latin American and Caribbean (LAC) environment ministers which was held in Brussels in March. These issues are especially significant given their importance for the economic well-being of EU, Latin American, and Caribbean countries. The issues raised at the meeting will provide the basis for the EU-LAC Heads of State and Government Summit in Lima in May.

Slovenian Environment Minister Janez Podobnik said, "Tackling climate change is the main environmental and development challenge of mankind. We already feel negative consequences of our behavior and unless we act decisively now on a global level, the consequences will become unmanageable."

Environment Commissioner Stavros Dimas said, "While Europe and Latin America and the Caribbean are geographically separate, we share a common environment, a common future and common challenges. Many of these challenges require global action for them to be overcome. The European Union is actively working to combat climate change, for example, but this battle cannot be won without the support of our partners in Latin America and the Caribbean. Given that these countries are a reservoir of biodiversity and forests it is absolutely essential that we work with them to stop the loss of species and their habitats."

In recent years the European Union has provided support to a number of environmental initiatives in Latin America and the Caribbean. This includes some €345

million from 2002 to 2007 for environment and climate change related activities, including promoting renewable energy and forest and biodiversity preservation.

From 2002 to 2006 the EU also co-financed 74 scientific and research projects for a total sum of €210 million which focused on climate change mitigation and adaptation, integrated ecosystem management, coastal zone and water management, biodiversity, and the health impacts of environmental problems.

For the years 2007 to 2010 the EU is expected to provide €100 million for projects in Latin America and the Caribbean in the area of forest management, deforestation, governance, and climate change adaptation. This support will also be complemented by financial assistance for projects focusing on themes such as the environment, the management of natural resources and energy (ENRTP), and on funding for research projects under the 7th Research Framework Program. The European Investment Bank will also make available approximately €2.8 billion in loans for projects focusing on environmental sustainability, climate change mitigation, greenhouse gas reduction, renewable energy and energy efficiency, and carbon capture and storage. □

