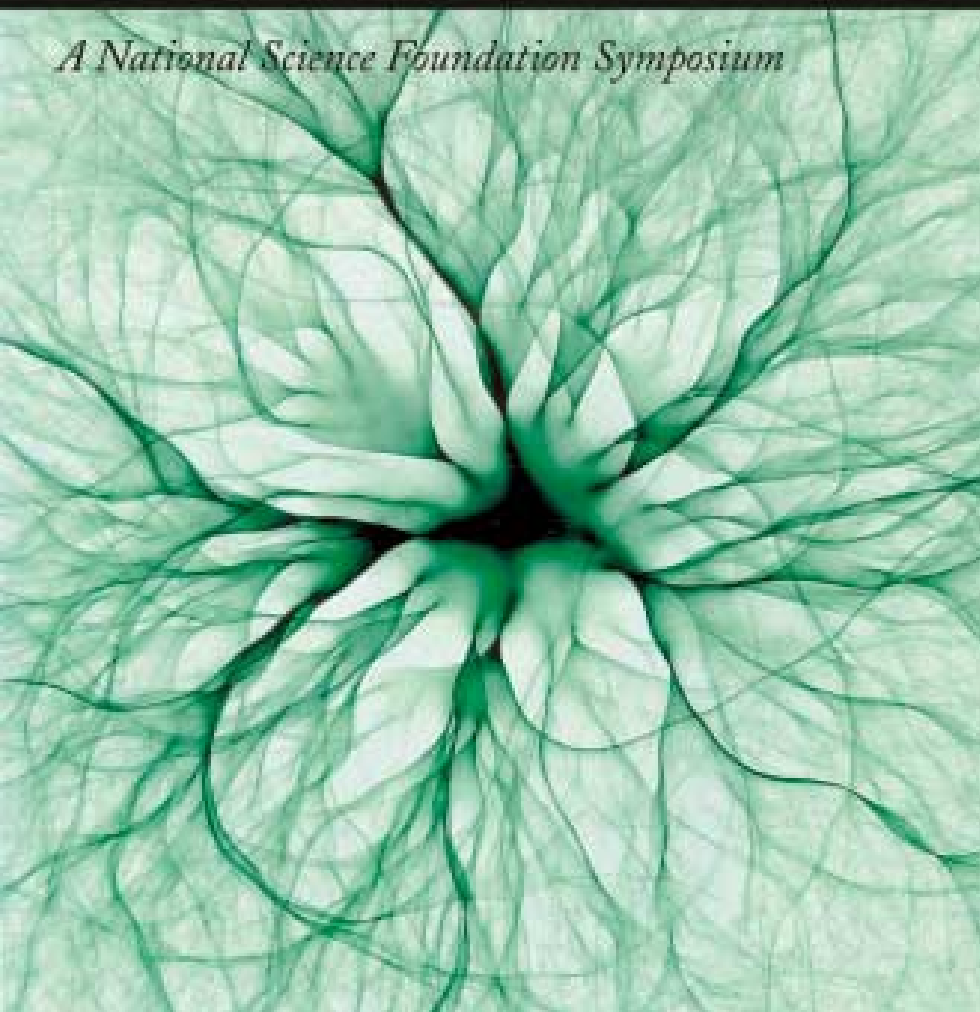


# SMALL WONDERS:

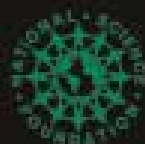
*Exploring the Vast Potential of Nanoscience*

*A National Science Foundation Symposium*



Amphitheater  
Ronald Reagan Building and  
International Trade Center  
Washington, D.C.

Tuesday, March 19, 2002  
8:30 a.m. - 5:30 p.m.



## FROM THE NSF DIRECTOR



Dear Colleague:

Nanoscience, nanoengineering and nanotechnology are relatively new words in the lexicon of science and engineering research and education. Researchers the world over are on the verge of profoundly changing the way we live and work through the ability to assemble materials and devices at the level of individual atoms and molecules. Many experts believe that nanoscale technology will have an impact on society equal to the Industrial Revolution. And it is happening now.

I am pleased that the National Science Foundation is hosting this symposium — “Small Wonders: Exploring the Vast Potential of Nanoscience” — where for the first time we showcase the most recent advances in nanotechnology. New drugs and medical treatments, ultra-tiny computers, materials lighter and stronger than any ever known and breakthroughs in energy production and environmental quality are literally the tip of the iceberg for the benefits that nanoscience and engineering can potentially yield to society. Some of those have become increasingly urgent since the events of Sept. 11. All of us have become more aware of the critical role that science and engineering play in enhancing our national security and nanoscale research will be essential to that effort.

I sincerely thank all of you who are participating as speakers and exhibitors. I hope everyone enjoys today’s exciting program.

A handwritten signature in black ink that reads "Rita R. Colwell". The signature is fluid and cursive, with the first name "Rita" being the most prominent.

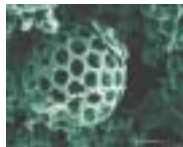
Rita R. Colwell  
Director

NSF has been a pioneer in fostering the development of nanoscale science and engineering through:

- Investments in the research of individual investigators and small interdisciplinary teams. About 1000 projects involving 5,000 faculty and students were supported in fiscal 2001.
- More than 15 large science and technology, engineering research and materials research centers in core research areas.
- Instrumentation and facilities such as the National Nanofabrication Users Network, which provides access to sophisticated technologies. Five university-based research hubs are focused on electronics, biology, advanced materials, optoelectronics and nanoscale computer simulation.
- Small business initiatives.

NSF's support spans multiple disciplines and is distributed across five directorates. The agency leads the National Nanotechnology Initiative and the National Science and Technology Council's Subcommittee on Nanoscale Science, Engineering and Technology, which aims to develop a long-term vision and establish federal priorities.

***The Federal Budget.*** In the FY 2002 budget, Congress appropriated \$579 million for nanotechnology research and development, including \$199 million for NSF. The FY 2003 federal budget request for nanotechnology research and development is increased by 17% from FY 2002 to \$679 million, including \$221 million for NSF. Other agencies supporting nanotechnology include the Departments of Commerce, Defense, Energy, Justice, the National Institutes of Health, and the National Aeronautics and Space Administration, among others.



# PROGRAM

8:30 A.M. – 9:00 A.M. REGISTRATION

9:00 A.M. – 9:15 A.M. **WELCOME & INTRODUCTION**

Symposium Moderator  
Esin Gulari  
Asst. Dir. (Acting) for Engineering  
National Science Foundation

Rita R. Colwell, Director,  
National Science Foundation

9:20 A.M. – 9:50 A.M. **KEYNOTE ADDRESS**

Richard E. Smalley, Nobel Laureate,  
Chemistry, Gene & Norman  
Hackerman Professor of Chemistry  
and Professor of Physics,  
Rice University

9:50 – 10:05 A.M. BREAK

10:10 A.M. – 10:30 A.M. **SMALL IS DIFFERENT...**

Arthur Ellis,  
University of Wisconsin-Madison

10:35 A.M. – 11:20 A.M. **...FROM MATERIALS TO MEDICINE**

Richard W. Siegel,  
Rensselaer Polytechnic Institute  
C. Mirkin, Northwestern University  
Karen Wooley, Washington University

11:25 A.M. – 11:45 A.M. BREAK

11:45 A.M. – 1:00 P.M. **... DEVICES, INSTRUMENTATION & ELECTRONICS**

Herb Goronkin, Motorola  
Donald Eigler, IBM, Almaden Labs  
Mark Lundstrom, Purdue University  
Karl Hess, University of Illinois  
Angela Belcher,  
University of Texas, Austin



1:00 – 2:00 P.M. EXHIBITS & LUNCH

2:15 P.M. – 3:25 P.M. ... **EDUCATION, ECONOMICS & THE VIEW FROM ABROAD**

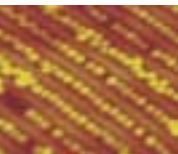
Sandip Tiwari, Cornell University  
Ralph K. Cavin, III,  
Semiconductor Research Corporation  
Vicki Barbur,  
Eastman Kodak Corporation  
Mihail C. Roco,  
National Science Foundation

3:25 P.M. – 3:40 P.M. BREAK

3:45 P.M. – 5:30 P.M. ... **ISSUES & IMPLICATIONS OF NANOTECHNOLOGY FOR SOCIETY**

DISCUSSION PANEL

Moderator: Joseph Bordogna, Deputy Director, National Science Foundation  
Discussants:  
Horst Stormer, Nobel Laureate, 1998, Physics, Columbia University, Lucent Technologies  
Richard E. Smalley, Nobel Laureate, 1996, Chemistry, Gene & Norman Hackerman Professor of Chemistry and Professor of Physics, Rice University  
Arun Majumdar, Associate Professor of Mechanical Engineering, University of California, Berkeley  
Robert Westervelt, Gordon McKay Professor of Applied Physics & Professor of Physics, Harvard University  
Samuel I. Stupp, Board of Trustees Professor of Materials Science, Chemistry & Medicine, & Director, Institute for Bioengineering and Nanoscience in Advanced Medicine, Northwestern University



## EXHIBITORS



- Ben Franklin Technology Partners
- California Molecular Electronics Corp.
- Digital Instruments Veeco Metrology Group
- Center on Nanostructural Materials and Devices, City College of New York, NYC



- National Nanofabrication Users Network
- National Nanotechnology Initiative
- Northwestern University
- University of Texas at Austin with DuPont



- University of Wisconsin at Madison
- NSF Nanoscale Science and Engineering Centers
  - Columbia University
  - Cornell University
  - Harvard University
  - Northwestern University
  - Rensselaer Polytechnic Institute
  - Rice University

## ABOUT THE NATIONAL SCIENCE FOUNDATION

Created in 1950, NSF is an independent U.S. government agency responsible for advancing science and engineering in the United States across a broad and expanding frontier. NSF carries out its mission primarily by making merit-based grants and cooperative agreements to individual researchers and groups, in partnership with colleges, universities and other institutions – public, private, state, local and federal – throughout the United States.

NSF invests in the best ideas from the most capable people, determined by competitive merit review. Each year, NSF receives about 30,000 proposals for research and education projects and funds about one-third of them. Awards typically go to universities, colleges, academic consortia, nonprofit institutions and small businesses.

Every dollar NSF spends is an investment in people. The agency supports nearly 200,000 people – teachers, students, researchers, postdocs and many others. NSF supports formal and informal science, mathematics, engineering and technology education at all levels. NSF also supports collaborative projects between universities and industry and U.S. participation in international cooperative research and education efforts.

By statute, NSF consists of the Director and the National Science Board, which is composed of 24 part-time members appointed by the President and confirmed by the Senate.

# NANO PHOTOGRAPH DESCRIPTIONS



Branched Electron Flow – Scanned microscope images of electron flow away from a quantum point contact.

*Robert Westervelt, Harvard University*



Polystyrene nanoparticles dynamically deposited into poly(dimethylsiloxane) grooves.

*Gilbert Walker, University of Pittsburgh*



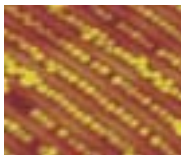
Photonic Crystals – (Supraballs)

*David Pine, University of California at Santa Barbara*



SEM photo revealing sharpness and the hexagonal structure of the ZnO nanotips.

*Yicheng Lu, Rutgers University*



AFM height image of 100nm polystyrene balls that have been lined up using a topographically patterned poly (dimethylsiloxane) surface.

*Gilbert Walker, University of Pittsburgh*



900 nm X 900 nm image of cholera toxin B oligomers (CTB) on a mica surface.

*Rong Wang, Illinois Institute of Technology*