NSF's Investment in Nanotechnology and Building the Nano Workforce

John A. Brighton
Assistant Director for Engineering

[See NSF Home Page – www.nsf.gov]

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“If I were asked for an area of science and engineering that will most likely produce the breakthroughs of tomorrow, I would point to nanoscale science and engineering.”

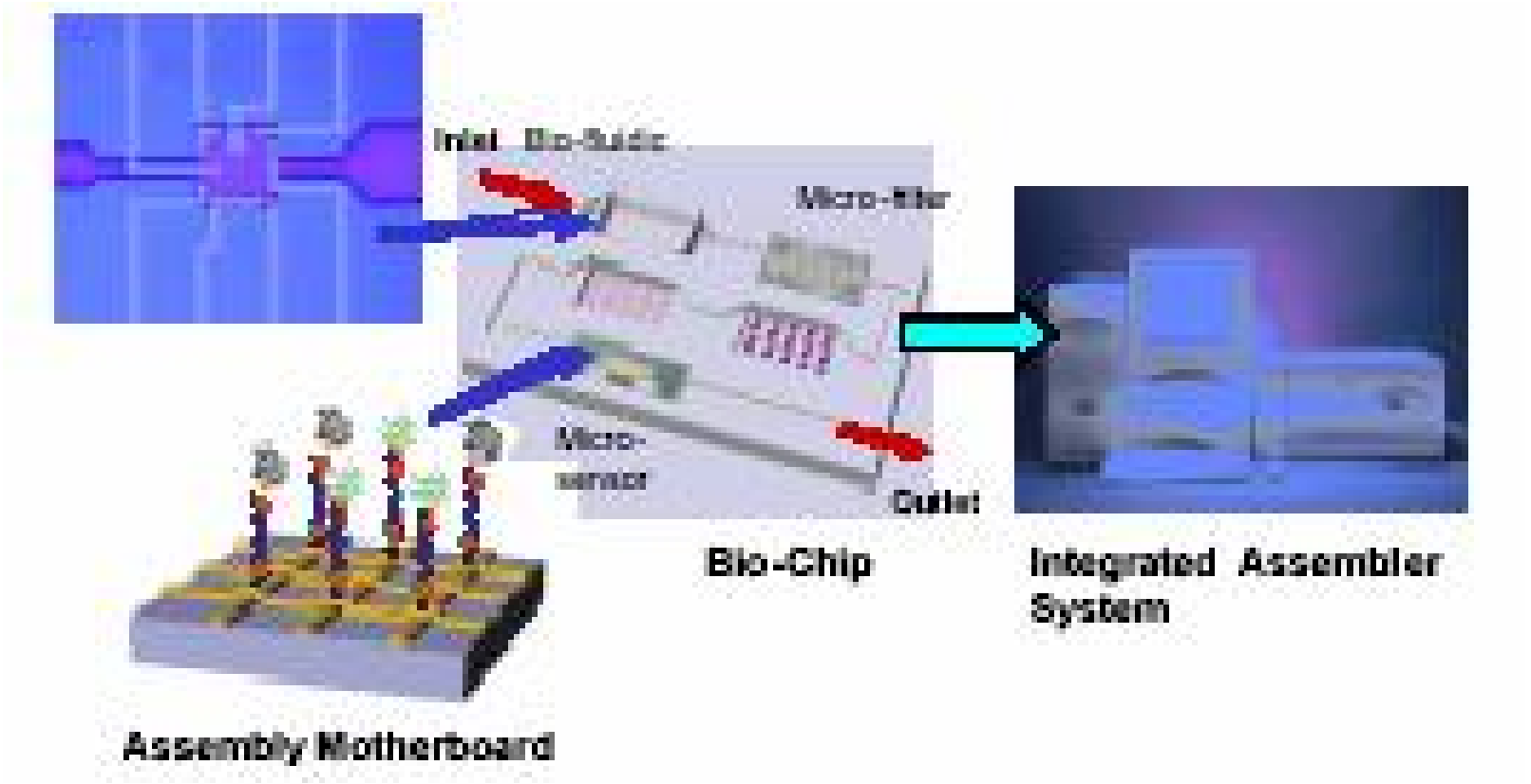
- Neal Lane

Assistant to the President

For Science and Technology

April 1998

Nanomanufacturing



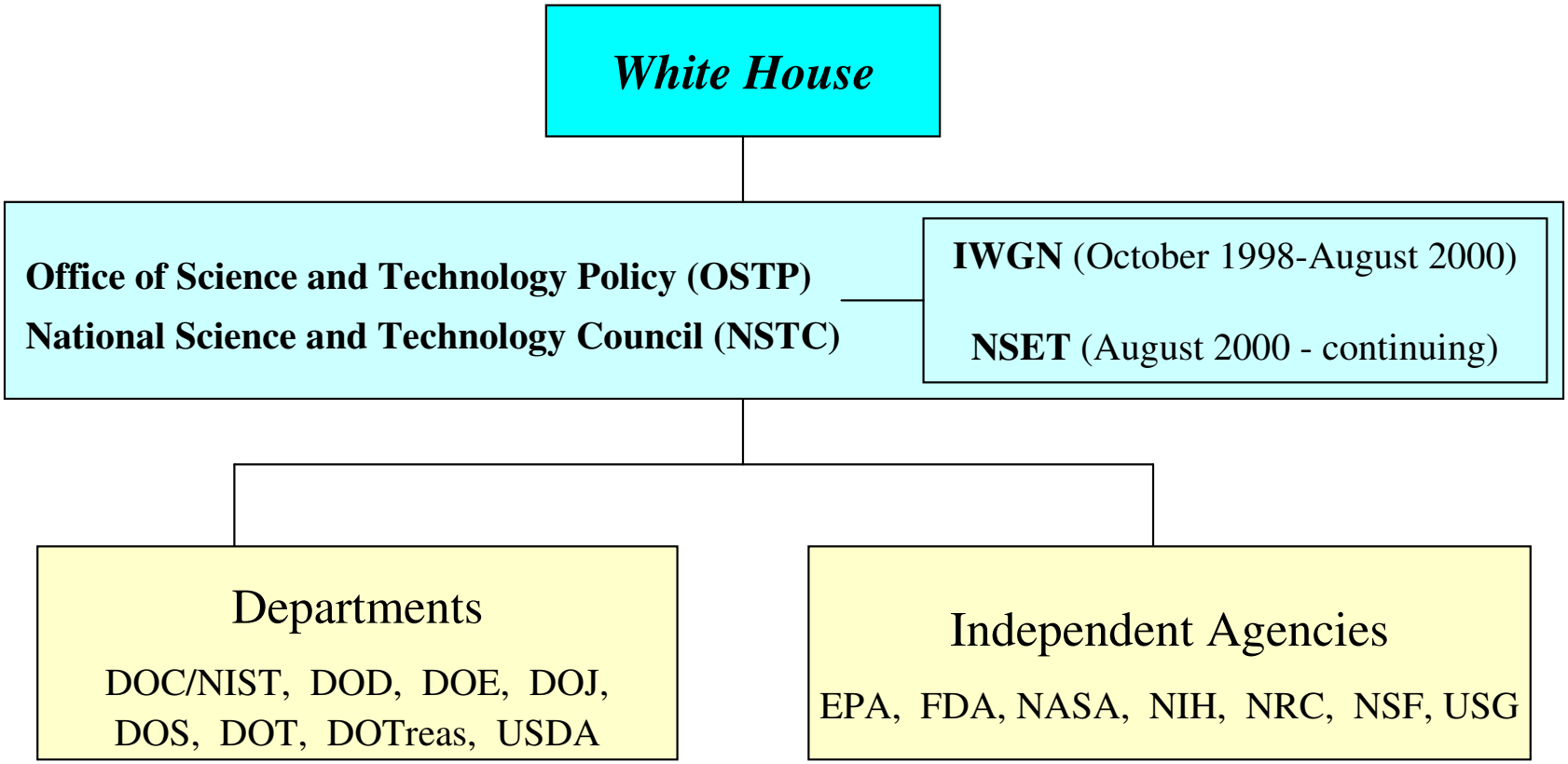
NNI & Nanotechnology Progress and Outlook

- $961M invested in NNI in FY 2004 (compared to $270M in FY 2000)
- 7000 people trained with NNI support in 2003
- Strong infrastructure created
  - Over 5,300 U.S. patents in FY 2003 (2/3 of world patents)
- $400M invested in nanotech start-ups in 2003
- Many new products using nanotechnology (estimated to be worth $1 trillion by 2015)

Examples of Nanotechnology Products

- Head for computer hard drives
- Magnetic recording tapes
- Solid-state compasses
- Landmine detectors
- Chemical hazards cleanup
- Molecular sensors
- Cancer detection agents
- Car body parts
- Paints and protective coatings
- Metal-cutting tools
- Sunscreens and cosmetics
- Stain-free clothing and mattresses
- Dental-bonding agent
- Burn and wound dressings
- Automobile catalytic converters
- Drug delivery systems
- Medical imaging devices
- Lasers with precise wavelengths
- Low friction coatings for submarines and ships

ORGANIZATIONS THAT HAVE PREPARED AND CONTRIBUTED TO THE NNI



NNI Budget Overview by Agency

(dollars in millions)

Agency	2003 Actual	2004 Estimate*	2005 Proposed	% Change, 2004 to 2005
NSF	221	254	305	20%
DOD	322	315	276	-12%
DOE	134	203	211	4%
HHS (NIH)	78	80	89	11%
DOC(NIST)	64	63	53	-16%
NASA	36	37	35	-5%
USDA	0	1	5	400%
EPA	5	5	5	0%
DHS (TSA)	1	1	1	0%
DOJ	1	2	2	0%
TOTAL	862	961	982	2%

About the National Science Foundation

- Established in 1950 to promote science and engineering (to advance National health, prosperity and welfare)
- Invests over $5.5 billion per year
- Annually receives 40,000 research and education proposals
- Uses peer review to select about 11,000 new projects each year

NSF Nanoscale Science and Engineering Funding

(Dollars in Millions)

	FY 2003 Actual	FY 2004 Likely Enacted	FY 2005 Request	Change Percent
BIO	3.0	5.3	5.9	10.2%
CISE	11.1	15.8	19.4	22.9%
ENG	94.4	108.9	133.8	22.9%
GEO	7.5	7.9	7.9	0.0%
MPS	103.9	111.5	132.1	18.5%
SBE	2.3	1.6	1.5	-3.8%
OISE	N/A	N/A	0.3	N/A
Subtotal, R&RA	222.2	251.0	300.9	19.9%
EHR	0.2	2.6	4.2	63.1%
Total, NNI	222.5	253.5	305.1	20.3%

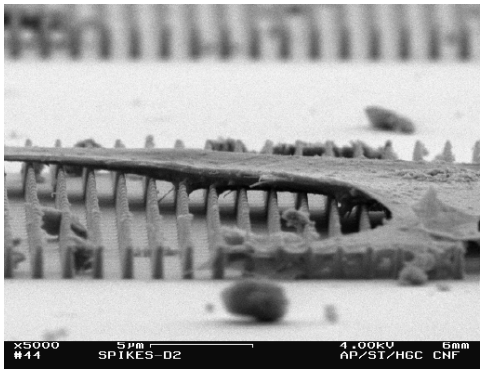
History of Nanotechnology in SBIR/STTR

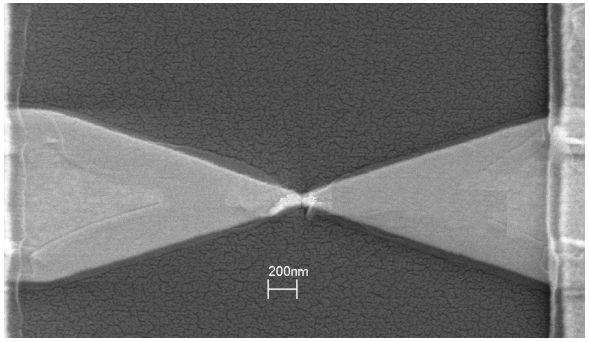
- FY 1998 "Nanotechnology" appeared in the STTR Program Solicitation
- FY 1999 to the present "Nanotechnology" a permanent subtopic
- Performance to date:
  - 232 Phase I awards
  - 60 Phase II awards
  - Investment $52 million (Approx. $10mm per year)

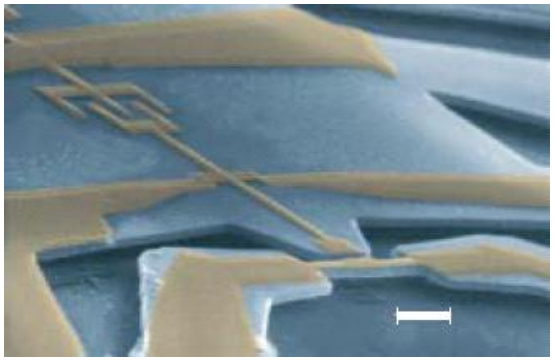
NNIN Attributes

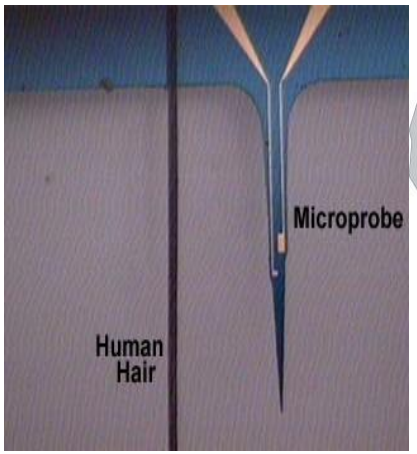
- Serves user communities across broad interdisciplinary domains
- Technically specialized facilities, and integrated general facilities
- Open access to all qualified users
- Supports remote users and complex projects across facilities
- Education/outreach – attention to underrepresented youth
- Assessment/metrics guide network evolution and allocation of resources

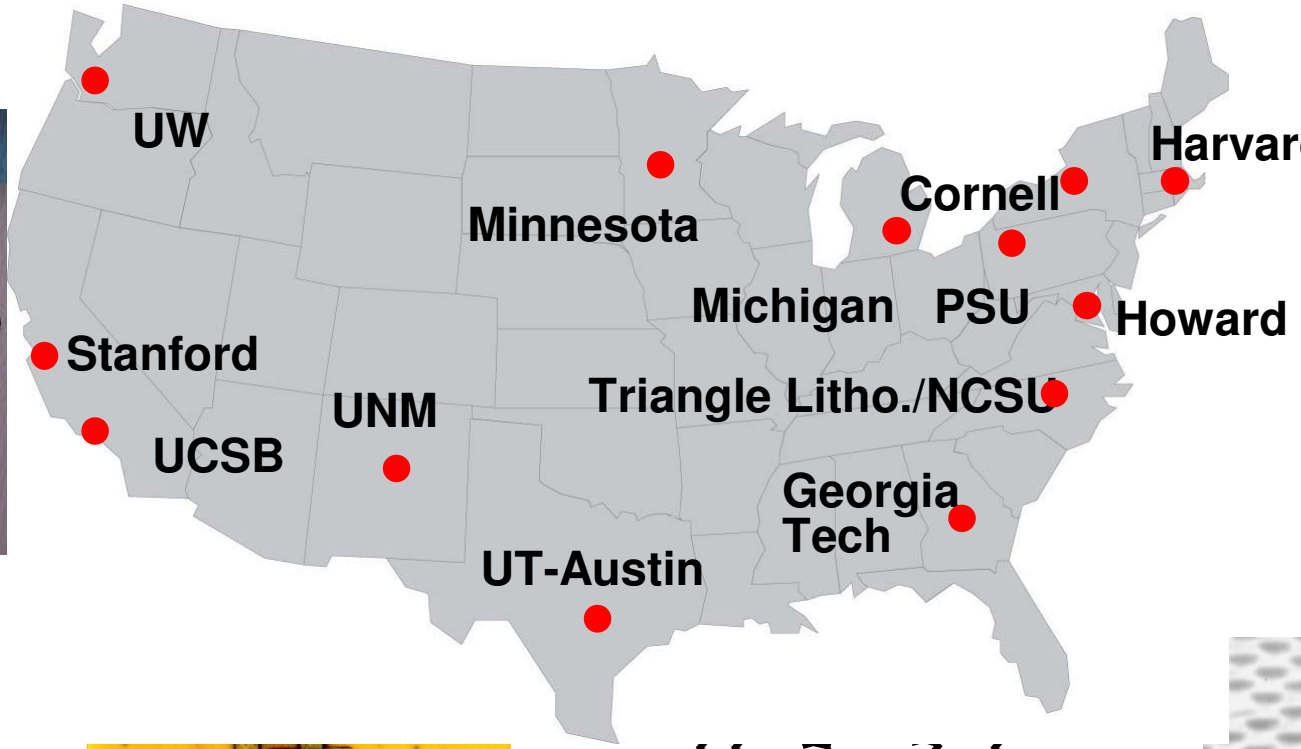
NNIN Sites/Capabilities

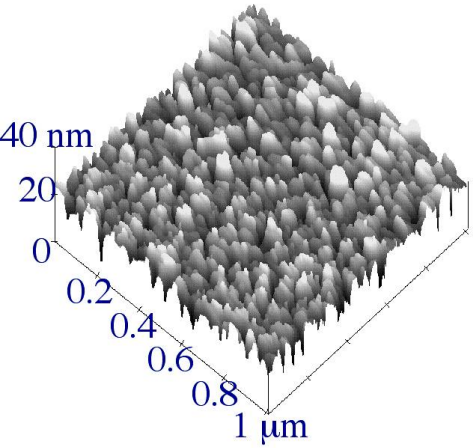


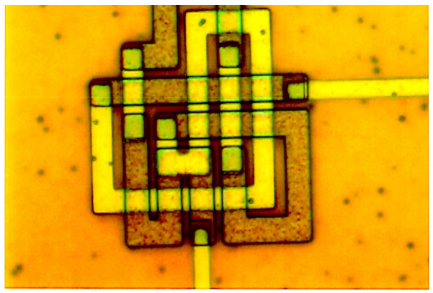


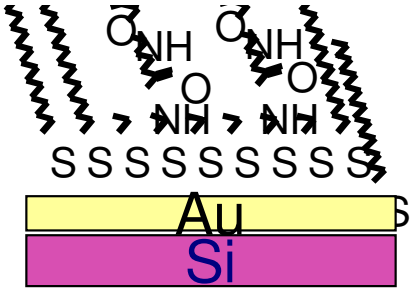


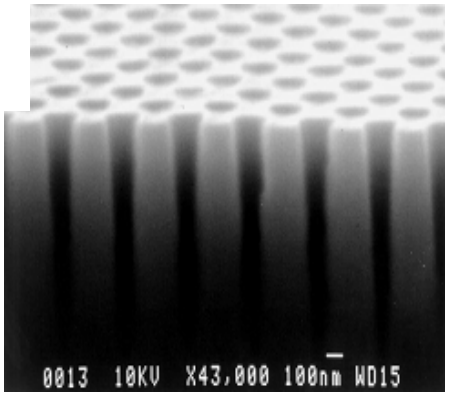













nodes
3 dependent
Source
Variables
5-1+3=7
7equations
22[A]
30[V]
5[A]
7[Ω]
9[Ω]
6[Ω]
7Vx
Vx
Vc

NSF/NNI EDUCATION AND TRAINING

- Integrating research and education (Make every lab a place of learning).
- K-12 outreach (All facilities and centers have education and outreach programs.)
- Curriculum development at all levels.
- Undergraduate, graduate and post-doc education, research and training.
- Societal Implications of Nanotechnology.

Nanotechnology Undergraduate Education Global Network Mark Hersam and Robert Chang

Northwestern University NUE-0304421

A web-based global infrastructure is utilized in stressing size-dependent phenomena in nanoscale structure-property relationships and materials processing techniques for controlling structure and properties at the nanometer length scale.

In an effort to promote student-centered communication and critical thinking skills, a Nanomaterials course employs non-traditional pedagogical practices involving collaborative group learning, interdisciplinary learning, problem-based learning, and peer assessment. Throughout the course, students solve interdisciplinary problems in groups and present their results to their peers for assessment. The final project is a research or small business proposal following National Science Foundation guidelines that is evaluated as both a written document and an oral presentation.

Nanotechnology, An Active Learning Experience for Undergraduates

Miguel Castro, U. Puerto Rico – Mayaguez

NUE-304348

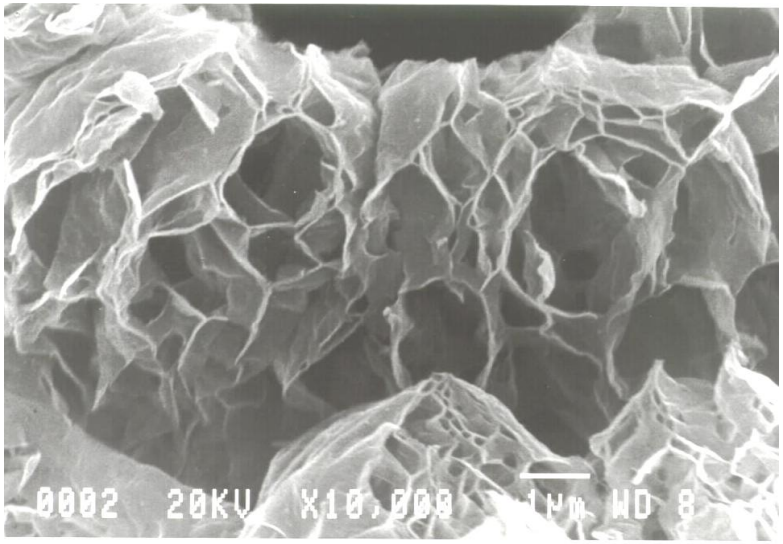
Integrating research into the curriculum, undergraduates developed a one-step-two-reactant approach to the synthesis of nearly mono disperse silver nanowires based on wet chemical methods.

Scanning electron microscopy reveals that the selectivity for nanowires over nanospheres is 100 %. The nanowires are about 200 nm in diameter and 2500 nm long.

Nanotechnology Across The Undergraduate Chemistry Curriculum

Tom Manning, Valdosta State U.

NUE-0303668



In new exploratory laboratories, students synthesize and trap the single molecule magnet, Mn12, inside a variety of matrices, such as single walled nanotubes and exfoliated graphite (shown in picture) in order to observe shifts in fundamental magnetochemistry properties in nanometer sized particles. Faculty and staff at the National High Field Magnet Lab work with the students to provide SQUID and TEM measurements.

"Nanotechnology has given us the tools . . . To play with the ultimate toy box of nature – atoms and molecules. The possibilities to create new things appear limitless."

- ***Horst Stormer***

  Physics Nobel Prize Winner

"Imagination Is more important than knowledge."

- Albert Einstein