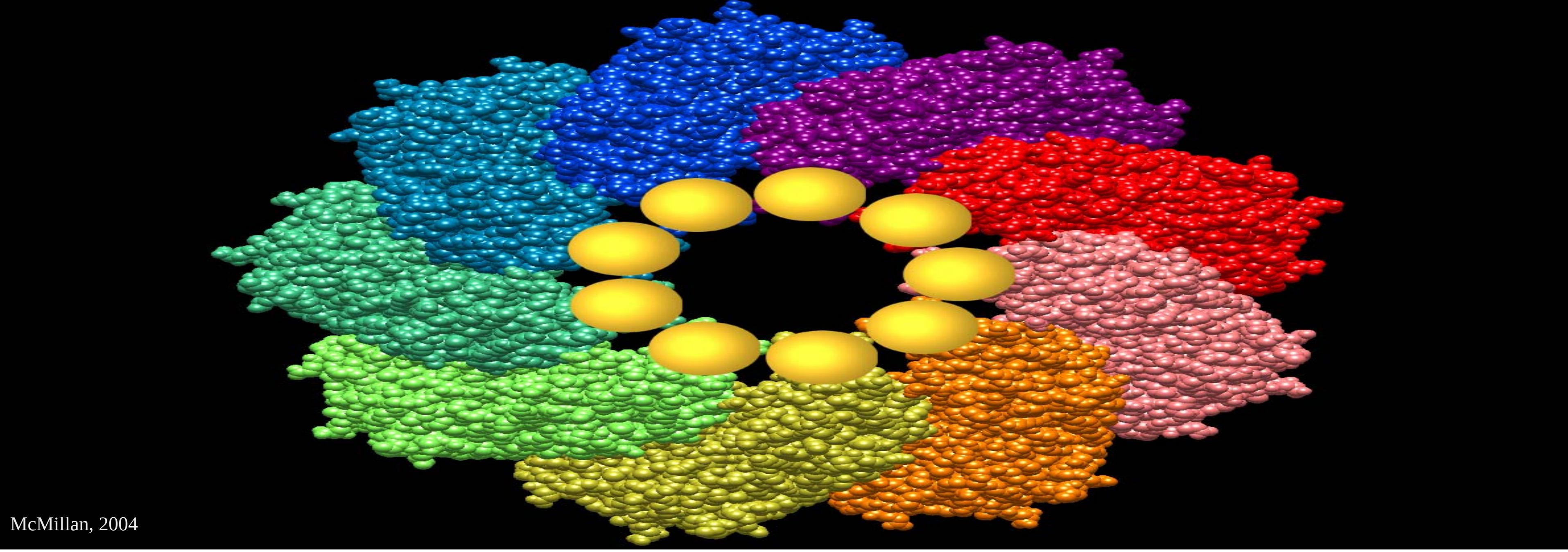


Nanotechnology in U.S. -
Research and education and risk governance

Dr. M.C. Roco

Chair, Subcommittee on Nanoscience, Engineering and Technology (NSET),
National Science and Technology Council (NSTC)

Senior Advisor for Nanotechnology, National Science Foundation

Buxton, October 12, 2004

Topics

- **National Nanotechnology Initiative - the program and its timeline**
- **Major changes in the first four years - setting new goals in 2004**
- **Societal implications: immediate and long term issues**
- **The international context**

Chances and risks of technology

- Human potential and technological development are coevolving, and quality of life has increased with technological advancements

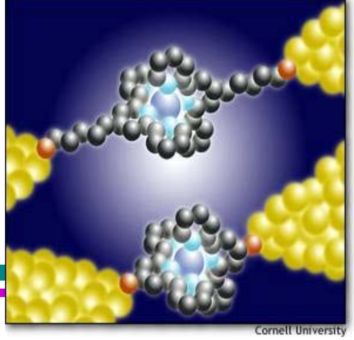
  However, there is a perceived tension between the society and technology (maybe because significant changes, accelerated path, larger benefits & risks)

- Technology implications are global issues (human development, EHS) that need to be addressed together

  NNI – promotes multidomain approach, interagency and international collaborations

Nanotechnology

Definition on www.nano.gov/omb_nifty50.htm (2000)



- **Working at the atomic, molecular and supramolecular levels, in the length scale of approximately 1 – 100 nm range, in order to understand, create and use materials, devices and systems with fundamentally new properties and functions because of their small structure**

- **NNI definition encourages new contributions that were not possible before.**

  - exploit novel phenomena, properties and functions at nanoscale, which are nonscalable outside of the nm domain
  - the ability to measure / control / manipulate matter at the nanoscale in order to change those properties and functions
  - integration along length scales into larger systems

NNI - Why nanotechnology is important?

- **Reaching at the foundation of matter**
  Historical event in understanding, control and transformation of natural/living and manmade systems (natural threshold)

- **The long term societal implications – driver 2000**
  Improved knowledge, quality of life, and environment
  Create foundation for a new industrial revolution

- **Higher purpose goals than development of NT**
  - More basic and unifying science and education
  - Higher efficiency processes and novel products
  - Molecular medicine
  - Extend the limits of sustainable development
  - Increased coherence/integration of S&T policies

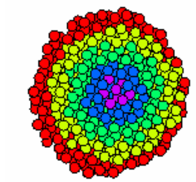
10-20 years vision

Timeline for beginning of industrial prototyping and commercialization

Increased integration, system approach

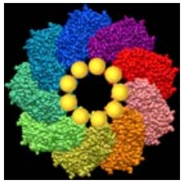
Converging science and engineering

- **1st Generation:** Passive nanostructures **~ 2001**



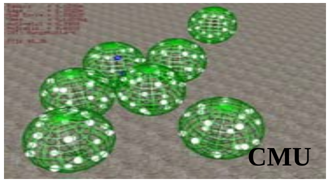
Ex: coatings, nanoparticles, nanostructured metals, polymers, ceramics

- **2nd Generation:** Active nanostructures **~ 2005**



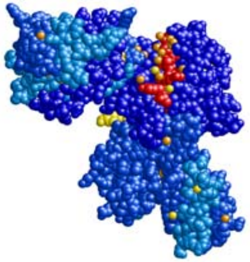
Ex: transistors, amplifiers, targeted drugs, actuators, adaptive structures

- **3rd Generation:** Systems of nanosystems **~ 2010**



Ex: guided molecular assembling; 3D networking and new system architectures, robotics, supramolecular

- **4th Generation:** Molecular nanosystems **~ 2020**



Ex: molecules as devices/components 'by design', based on atomic design, hierarchical emerging functions, evolutionary systems

AIChE Journal, 2004, Vol. 50 (5), MC Roco

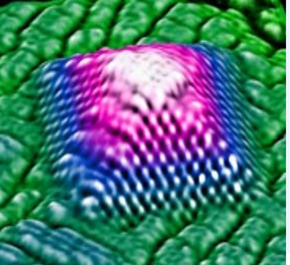
BROAD SOCIETAL IMPLICATIONS: Unexpected consequences and risks

(sample of issues)

- **Knowledge base**: creation of organisms? philosophical issues?
- **New technologies and products**: industry restructuring?

  Materials beyond chemistry: new material properties? safety?
  Electronics: society as an interconnected brain? privacy?
  Pharmaceuticals: secondary effects of medication? behavior control?
  Quality of life? New chemical manufacturing methods? . . . . .

  Changing jobs and organizations. Nano-divide?
- **Improved healthcare**: ethical and social issues? human dignity?
- **Sustainability**: impact of nanostructures on environment? cleaning existing contaminants? What is the new population limit for sustainable development with nanotechnology?

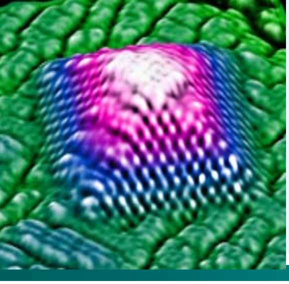


NATIONAL NANOTECHNOLOGY INITIATIVE

- Timeline (Preparing NNI) -

- March 1991 “Nanoparticle Synthesis and Processing” (NSF program)
  First workshop including safety of nanoparticles (Nov. 1990)
- Nov. 1996 Nanotechnology Group (bottom-up)
- **Sept. 1998 NSTC establishes Interagency Working Group of Nanoscience and Engineering (IWGN)**

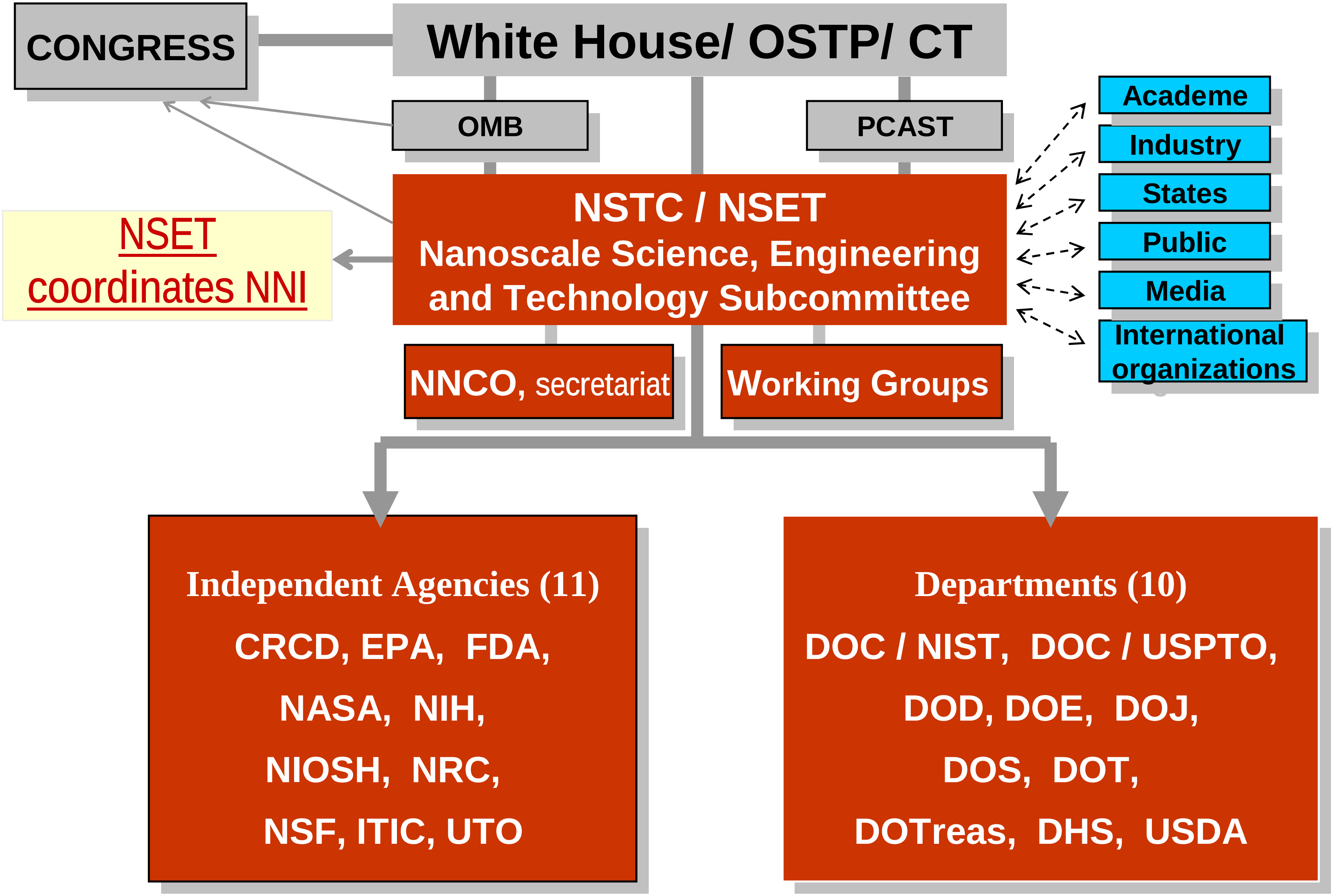
- March 1999 OSTP/CT presentation on NNI, Indian Treaty Room
- Oct. – Dec. 1999 OMB review – NNI the only new topic recommended
  PCAST – Letter to the President supporting NNI
  OSTP and WH Approval
- **Jan. 2000 NNI announced by the President in Jan 2000**



NATIONAL NANOTECHNOLOGY INITIATIVE

- Timeline fiscal years (FYs) 2001-2004 -

- **Feb. – Dec.. 2000: WH Congress review and approve FY 2001 NNI**
  NSTC establishes NSET for implementation NNI, July 2000
  "Societal Implications" workshop in Sept. 2000
- **FY 2001** **6 agencies;** actual investment **$465M**
  Concerns about the interest, "science fiction" perception
  MOU to establish NNCO, Jan. 2001
- **FY 2002** **12 agencies**; actual investment **$697M**
  International reaction: programs in 30 countries
  Industry get involved in many sectors
  20 states and regional alliances begin to invest
- **FY 2003** **16 agencies** ; actual investment **$862M**
  Outcomes: research, education, industry and
  states investments, patents, IPO; GMO perspective
- **FY 2004** **21 agencies,** WH Request - **$961M;**
  2 Bills in Congress for FY04-08; The President signs
  Public Law 108-153 "21st Century NT R&D Act"
  OSTP-OMB: NNI is a national priority



National Nanotechnology Initiative coordination

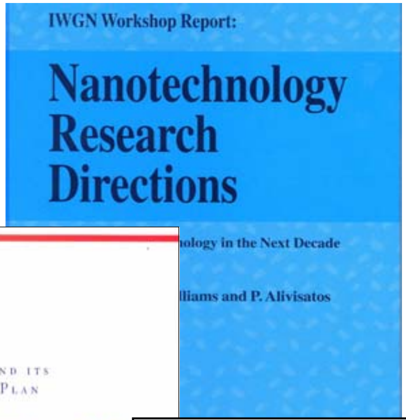
(Levels: National / Federal agencies, Each agency / Partnerships with industry, states, regional, international / Interaction with public, media)

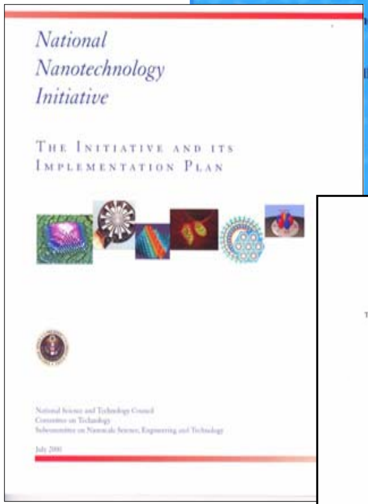
Defining the vision (I)

National Nanotechnology Initiative

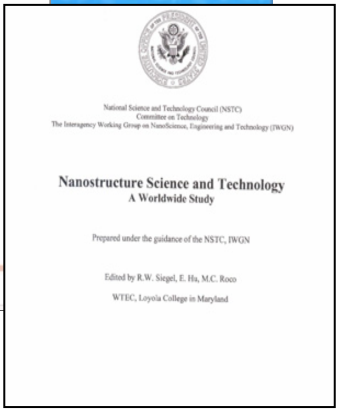
1999-2000

1999: 10-year vision



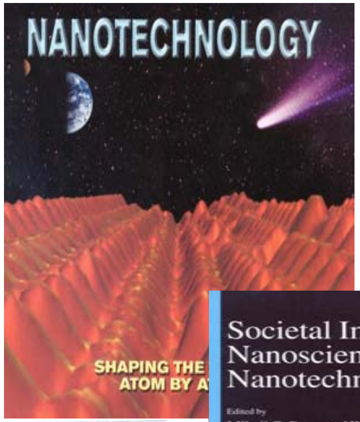


Government plan



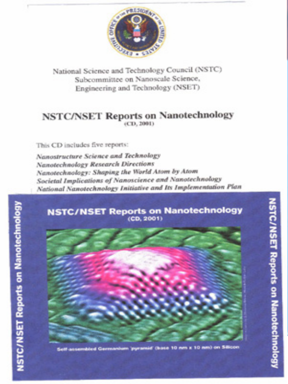
Reports

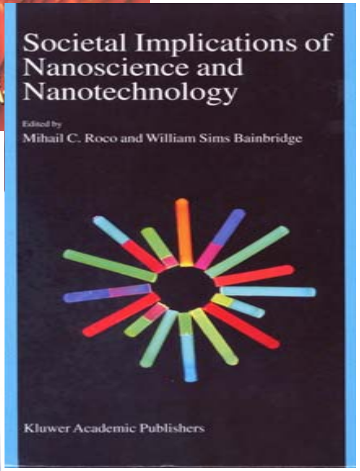
Worldwide benchmark



Brochure for public

Societal implications





FY 01-05: RD1 provides a foundation for annual NNI plans

June 2002: "Review of NNI" by U.S. Academies for WH/OSTP

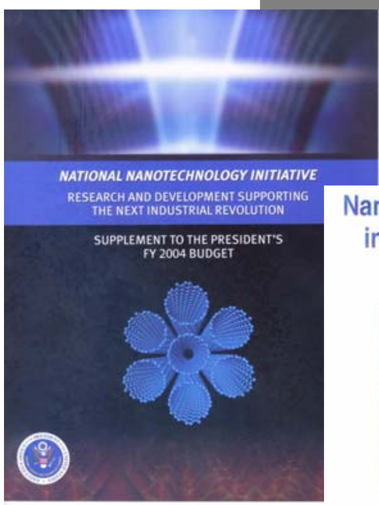
Focus on Knowledge Creation: same principles, phenomena, tools, architectures to support innovation in various areas of relevance

Defining the vision (II)

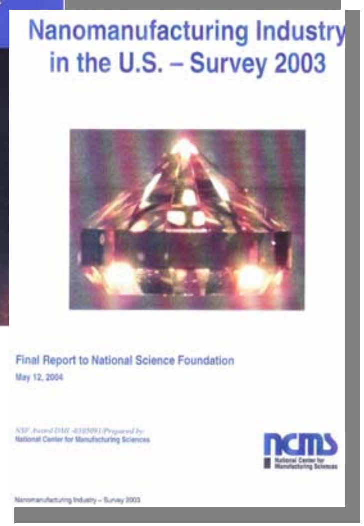
National Nanotechnology Initiative

2004

2004:
10-year
vision

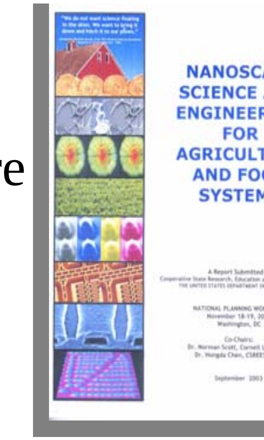


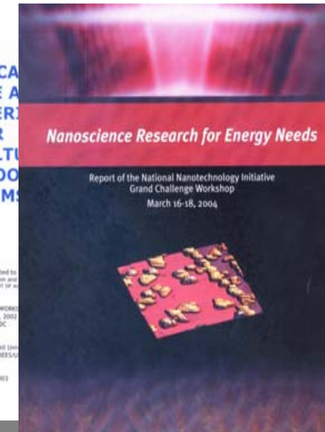
Government
Plan (annual)



Survey
manufacturing

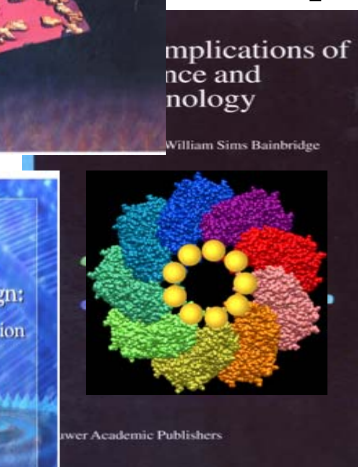
Agriculture
and Food



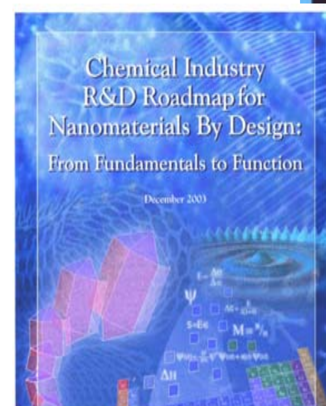


Energy

Societal
Implications
2004



Reports



Other topical reports
on www.nano.gov

2004: Update 10 year vision, and develop strategic plan

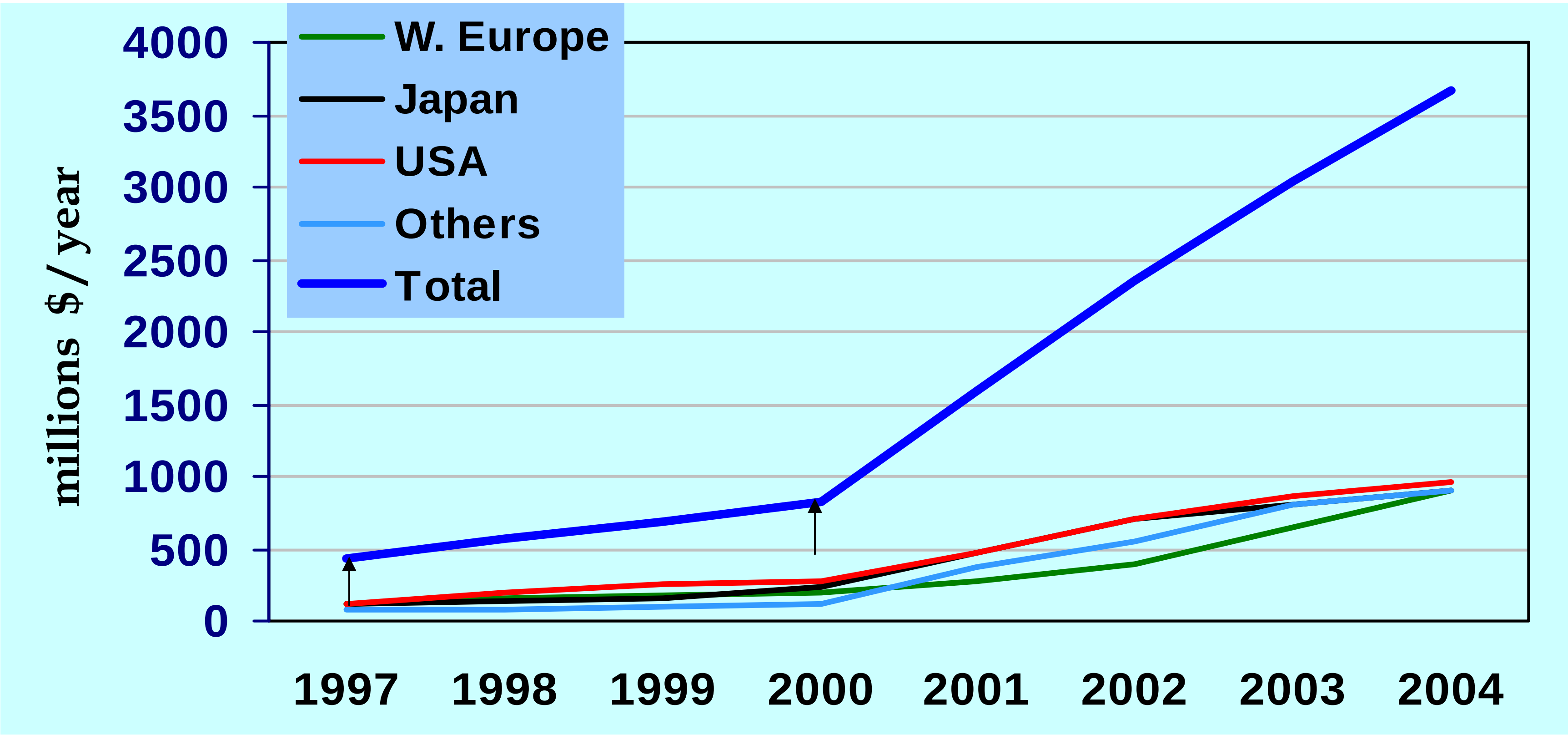
NNI: R&D Funding by Agency

Fiscal year (all in million $)	*2000* Actual	*2001* Enact/Actual	*2002* Enact/Actual	*2003* Enact/Actual	2004 Req./ Enact	2005 Req
National Science Foundation	97	150 /150	199 /204	221 /221	249 /254	305
Department of Defense	70	110 /125	180 /224	243 /322	222 /315	276
Department of Energy	58	93 /88	91.1 /89	133 /134	197 /203	211
National Institutes of Health	32	39 /39.6	40.8 /59	65 /78	70 /80	89
NASA	5	20 /22	35 /35	33 /36	31 /37	35
NIST	8	10 /33.4	37.6 /77	66 /64	62 /63	53
EPA	-	/5.8	5 /6	5 /5	5 /5	5
Homeland Security (TSA)	-		2 /2	2 /1	2 /1	1
Department of Agriculture	-	/1.5	1.5 /0	1 /1	10 /1	5
Department of Justice	-	/1.4	1.4 /1	1.4 /1	1.4 /1	1
TOTAL	270	422 /465	600 /697	770 /862	849 /961	982
		+72%	+50%	+24%		

- Industry, state and local organizations: about 1.5 times NNI budget in 2003
- 21 NSET departments / agencies, including: OSTP, NSTC, OMB, DOC, DOS, DOT, DOTreas, FDA, NRC, DHS, IC, NIOSH, USPTO; partnerships with others
- NNI budget: 65% to academia; 25% - R&D labs; 10% - industry (7% SBIR)

Context – Nanotechnology in the World

Past government investments 1997-2004 (est. NSF)



Note:

- U.S. begins FY in October, six months in advance of EU & Japan (in March/April)

About 50% of the highly cited papers in key journals originate in US, and about 35% in Europe

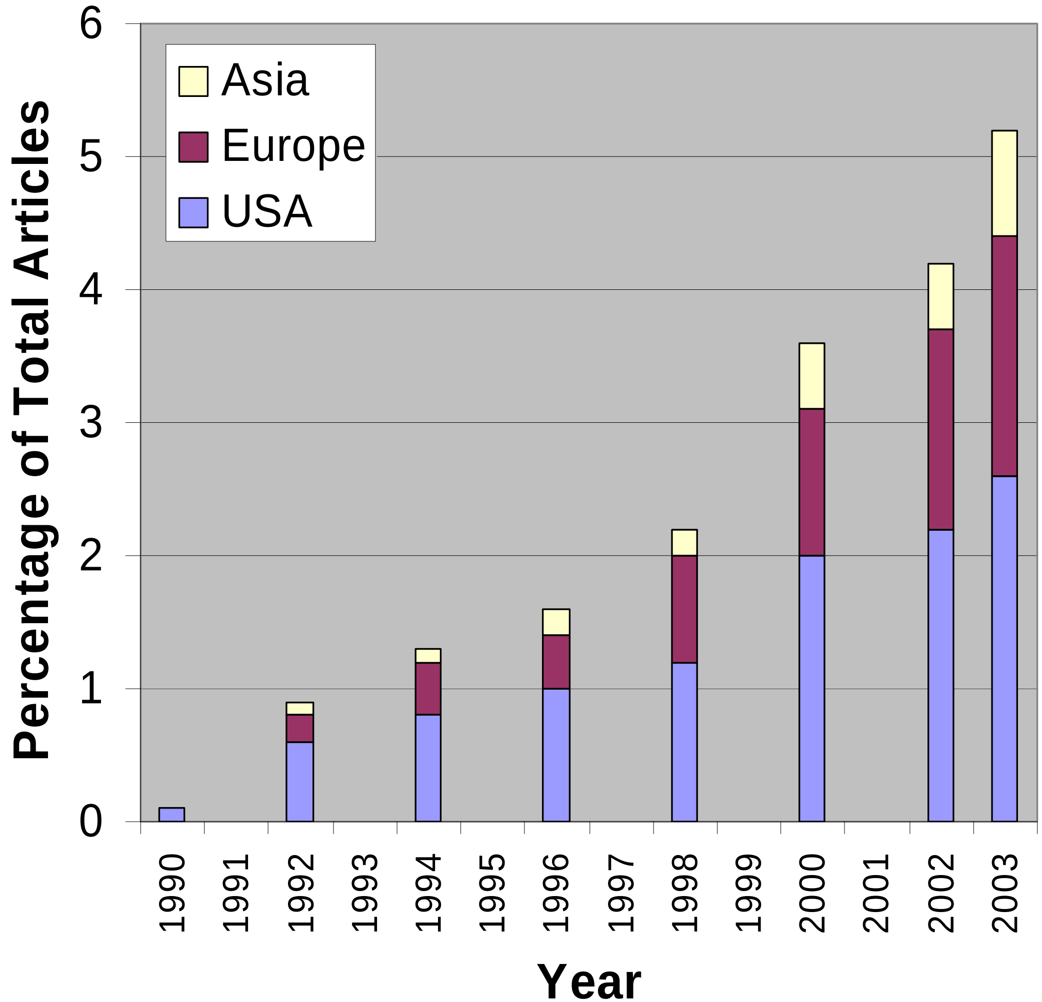
("nano*" keyword search, after NNI Report, 2005)

Journal ISI with high Impact Factors (2001):

Nature	27.9
Science	23.3
Physics Review Letters	6.6

All others journals have impact factors under 4

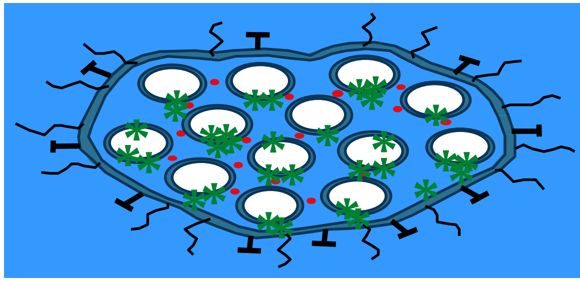
Correlates well with the overall papers with ISI high impact



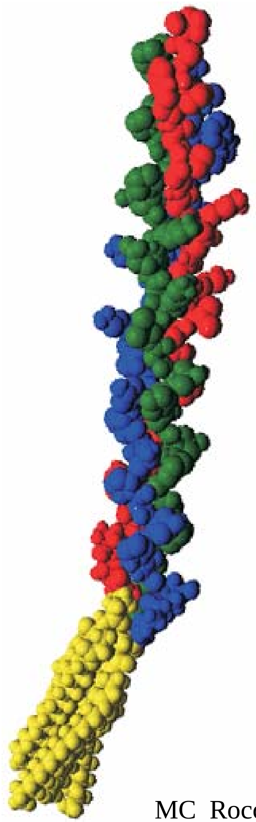
Example:

Synthesis and control of nanomachines

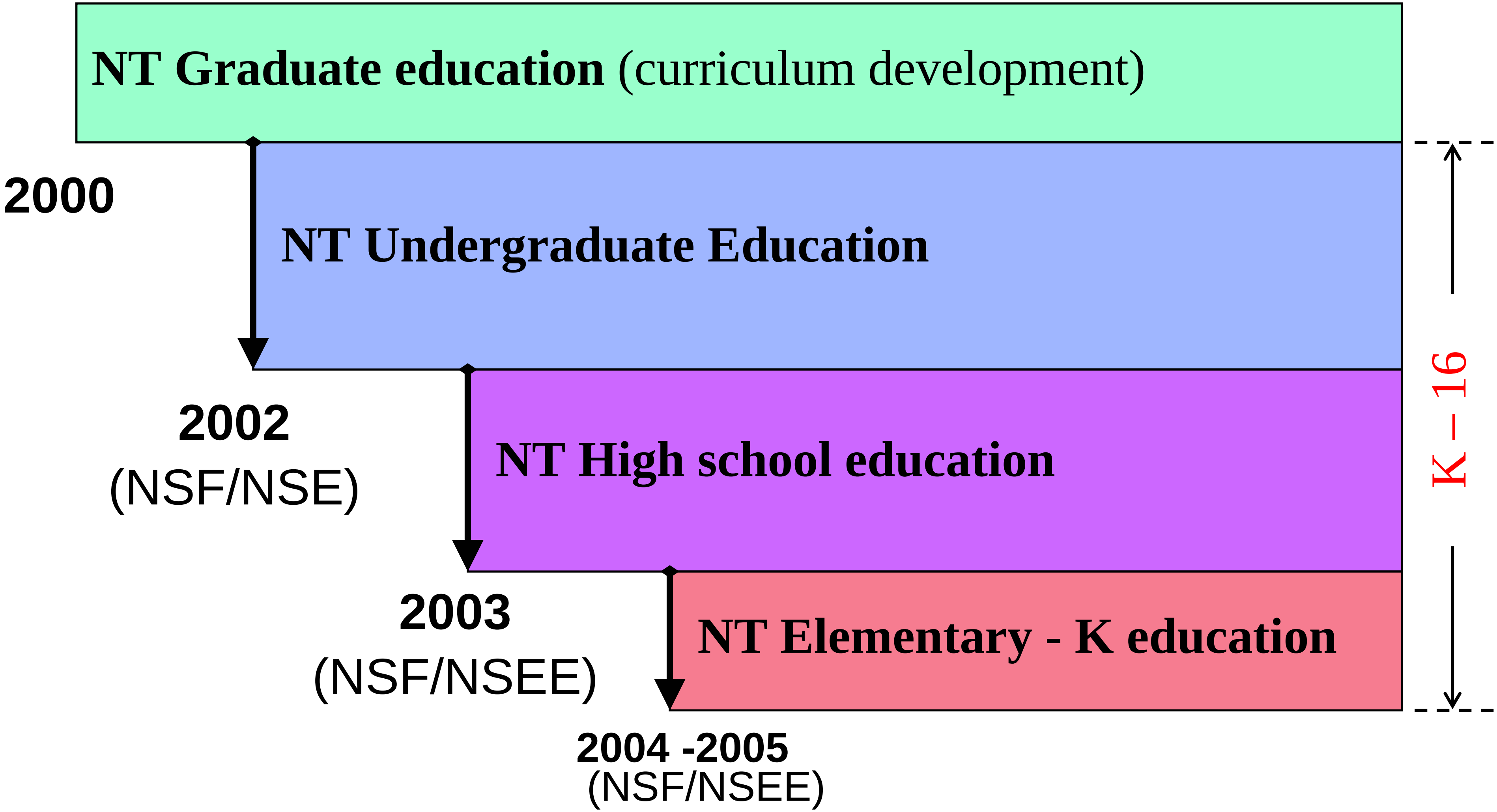
(examples NSE in 2004, www.nseresearch.org - 250 projects)



- **Self-assembly processing** of nanoscale bio-materials and devices for micromachines components (UCSB)
- Chemistry to synthesize components of **nano machines to work on surfaces** and be activated by external electromagnetic fields (UCB)
- **Light driven molecular motors** (U. Nevada)
- **Combinatorial engineering of nanomachines**, with application to membranes and filters (U. Penn.)
- **Nanoengineering surfaces** for probing viral adhesion (UC Davis)



Introducing earlier nanotechnology education
(NSF: Nanoscale Science and Engineering Education)



Infrastructure Outcomes of 2001-2004: R&D Networks and User Facilities

- **Network for Computational Nanotechnology** (NCN)
  7 universities (Purdue as the central node)
  Nanoelectronic device simulation/modeling

- **National Nanotechnology Infrastructure Network (NNIN)**
  13 universities with user facility
  Development measuring & manufacturing tools, including NEPM
  Education and societal implications

- **Oklahoma Nano Net (EPSCoR award)**

- **DOE network for large scale facilities: 5 National Labs**

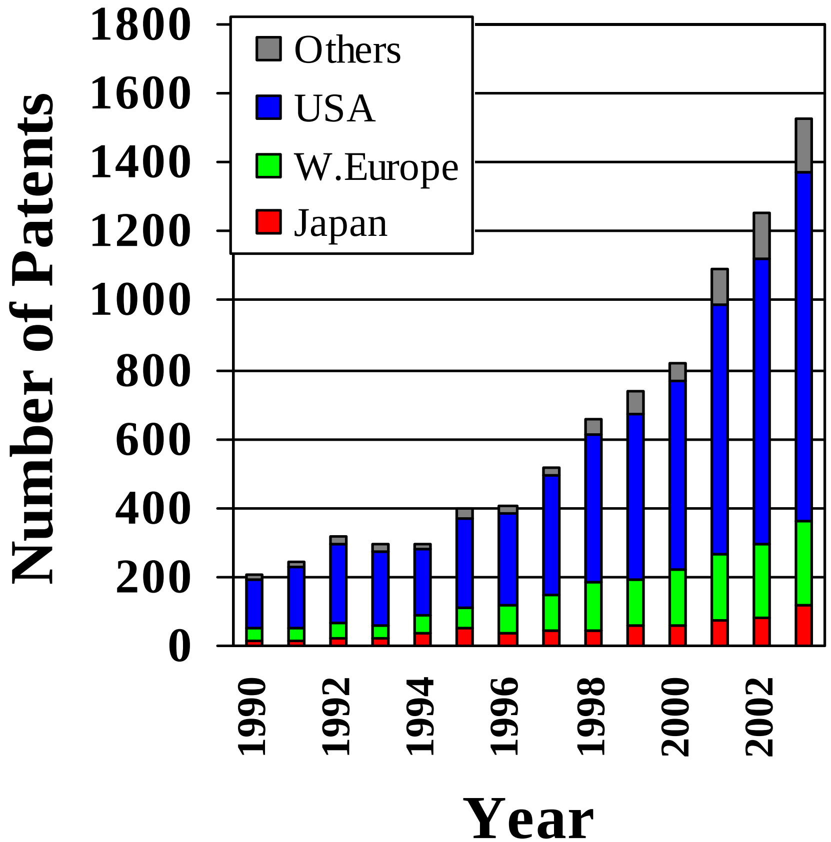
31 new centers and networks supported by NNI since 2001:

19 NSF, 5 DOE, 3 DOD, 4 NASA (at universities); continuing MRSECs

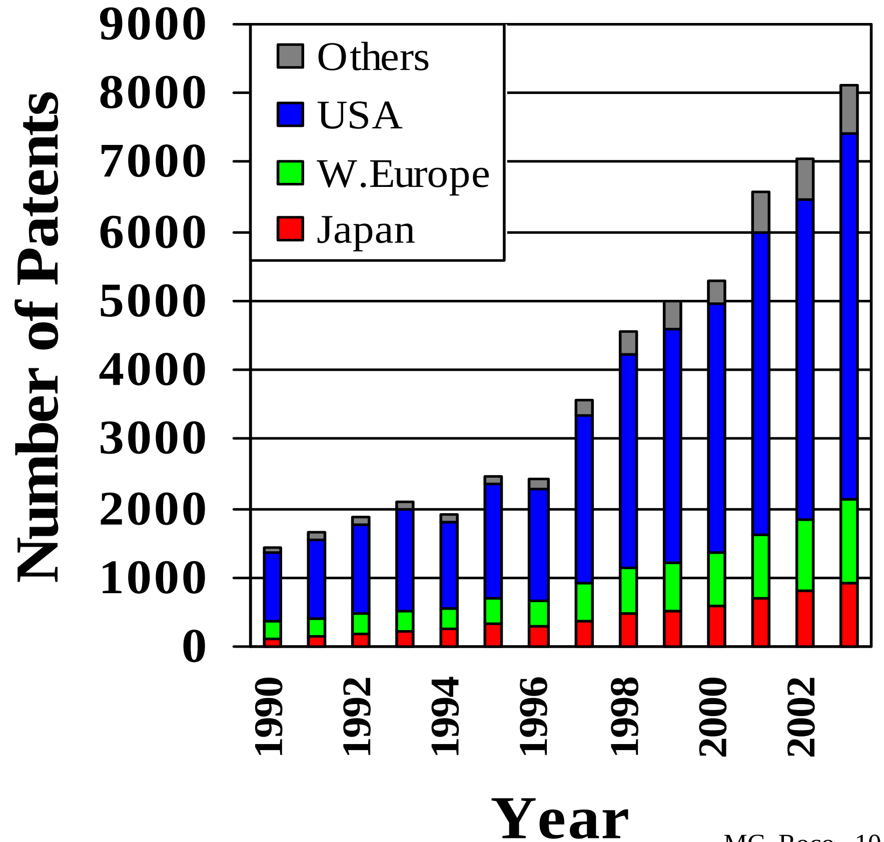
US has about 61% of world NT Patents (USPTO database)

using "Title-claims" and "Full-text" search for nanotechnology by keywords
(using intelligent search engine, after J. Nanoparticle Research, 2004, Vol. 6, Issue 4)

"Title-claims" search:
<u>nanotechnology claims</u>



"Full-text" search:
<u>nanotechnology claims, or/and NSE tools and methods</u>



MC Roco, 10/12/04

NNI-Industry Consultative Boards for Advancing Nanotech

Key for development of nanotechnology, Reciprocal gains

- **NNI-Electronic Industry (SRC lead), October 2003**
  - Collaborative activities in key R&D areas
  - 5 working groups, Periodical joint actions and reports
  - NSF-SRC agreement for joint funding; other joint funding
- **NNI-Chemical Industry (CCR lead)**
  - **Joint road map for nanomaterials R&D**
  - **2 working groups, including on EHS**
  - **Use of NNI R&D results, and identify R&D opportunities**
- **NNI – Organizations and business (IRI lead)**
  - **Joint activities in R&D technology management**
  - **2 working groups (nanotech in industry, EHS)**
  - **Exchange information, use NNI results, support new topics**
- **In developments: NNI - Pharmaceuticals (Phrma lead)**
  NNI - Automotive industry

Industry surveys

- Companies working in nanotechnology

Survey by Small Times in 2004, based on individual contacts and direct verification:

875 nanotech companies

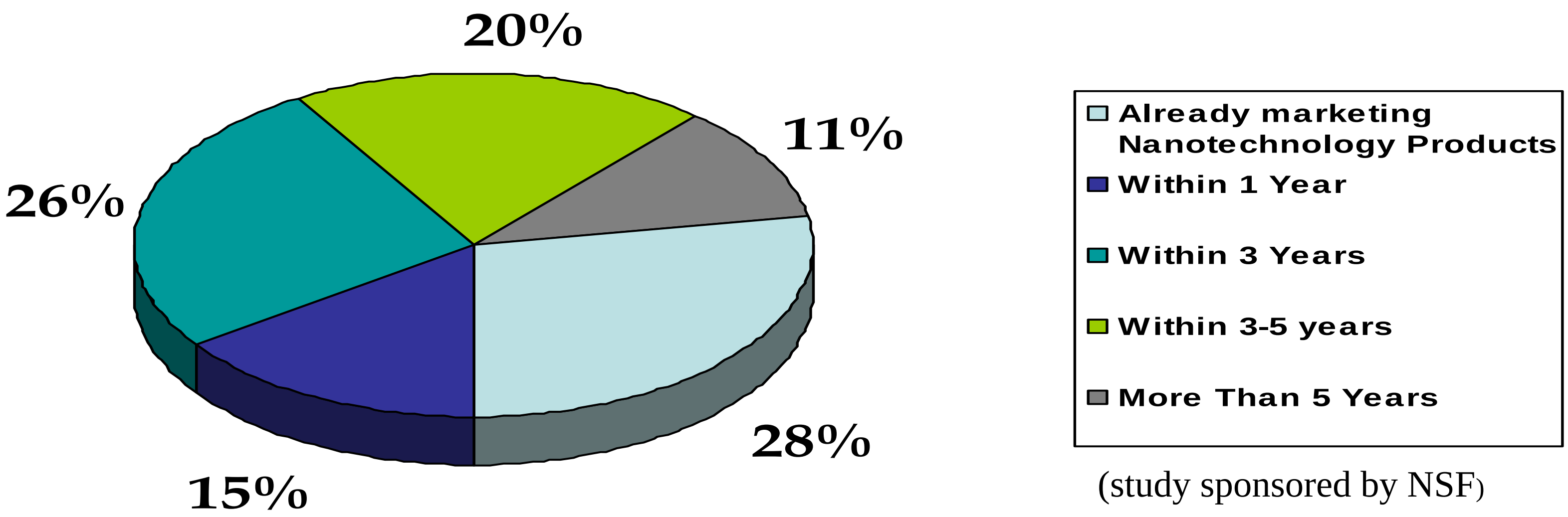
475 products in 215 companies

- Timeline for commercialization

Survey by National Center for Manufacturing Sciences:

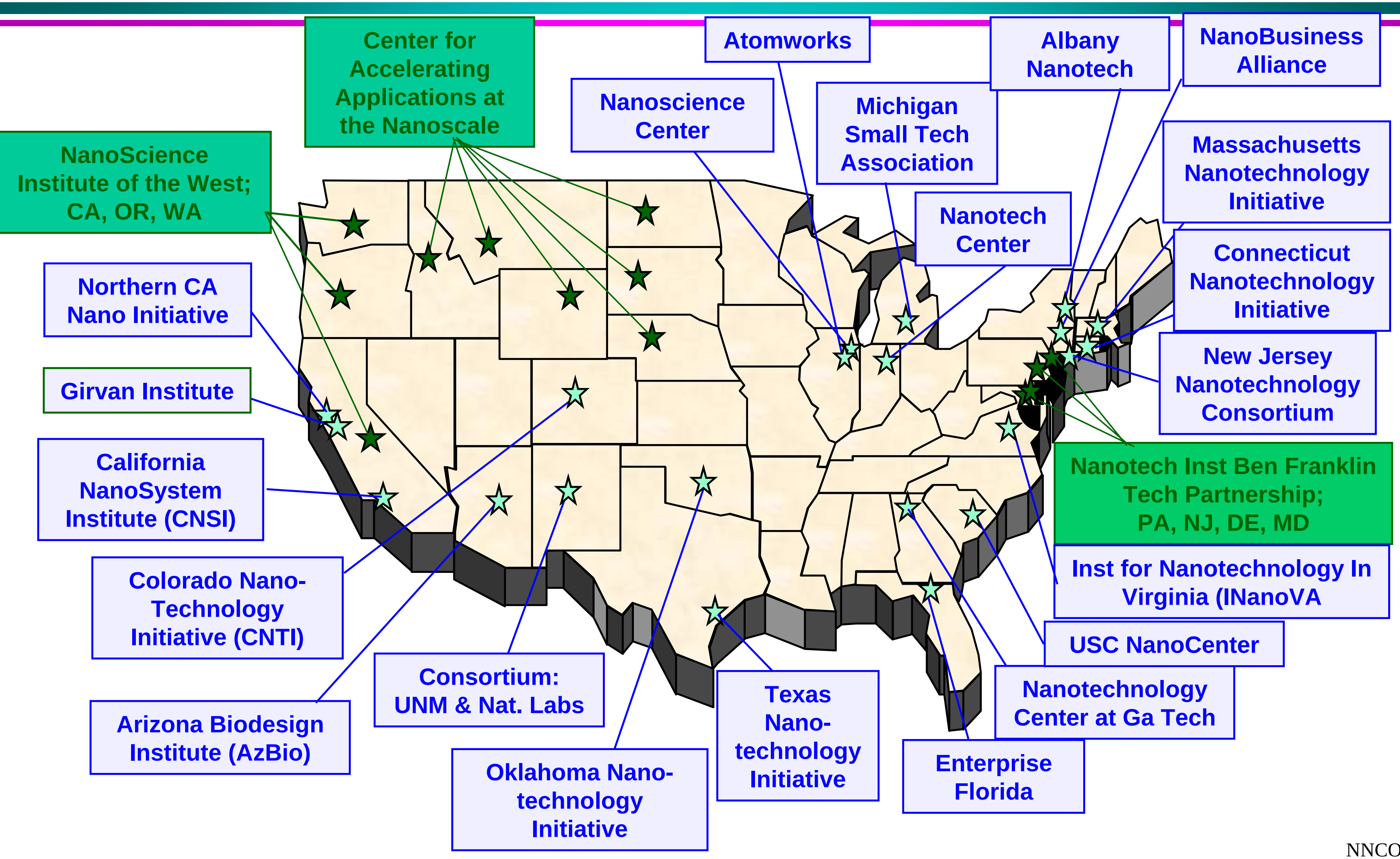
81 manufacturing companies:

89% expect products in less than 5 years

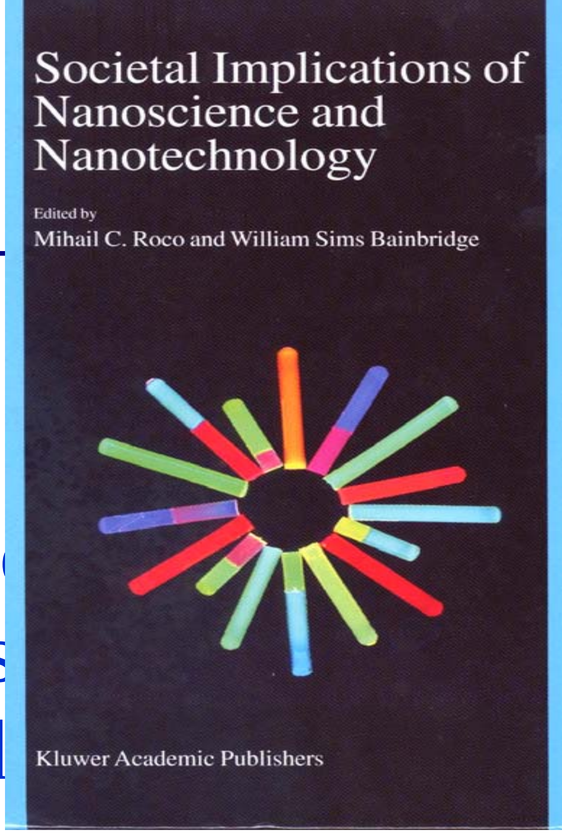


(study sponsored by NSF)

Sampling of Current Regional, State, & Local Initiatives in Nanotechnology



Societal Implications: Follow-up of the September 2000 report



http://nano.gov

- Make support for social, ethical, and economic research studies <u>a priority</u>:
  (a) New theme in the NSF program s
  (b) Centers with societal implications
  (c) Initiative on the impact of technol
  NBIC, HSD

- <u>NNCO</u> – communicate with the public and address EHS, unexpected consequences
- <u>International links:</u> Americas, Asia, Europe
- <u>Periodical Societal Implications / Env. meetings</u>

Key issues in long term

- Respect human right to: access to knowledge and welfare; human integrity, dignity, health and safety
- Balanced and equitable R&D nanotechnology investment
- Environment protection and improvement (water, air, soil) Sustainable development, life-cycle of products, global effects (weather), eliminate pollution at the source
- Economic, legal, ethical, moral, regulatory, social and international (developed-developing countries) aspects Interacting with the public and organizations
- Adaptive/corrective approach for a complex system

Immediate and continuing issues:

- *EHS in research laboratories and industrial units*
- *Harmonizing nomenclatures, norms and standards*
- *Primary data and methodology for risk analysis*

NNI activities

for Environmental, Health and other Societal Implications

A. Align R&D investment with societal implications

B. Evaluate and implement regulatory standards

C. Coordinated measures for EHS and ELES

D. Periodical meeting for grantees,
setting research targets, and
interaction with industry and the public

E. International collaboration (International Dialog
for Responsible R&D of Nanotechnology)

A. NNI coordination for R&D investments

- NSF research grants on environmental and societal implications
  All basic R&D areas, fate and transport of particles; Programs since 2000
- NIH research on effects of nanoscale materials in the body
- EPA research grants on environmental implications of manufactured nanomaterials
- National Toxicology Program (NIEHS, NCTR, NIOSH)
  Project to study toxicity of nanotubes, quantum dots, and titanium dioxide
- NIST development of standards and measurements for nanoscale particles
- FDA and USPTO training and specialized activities
- USDA and DOE support fate and transport studies
- DOD supports exposure studies
- Solicitations (SI): NSF (ENV, SI), EPA-NSF-NIOSH, USDA, NIH

Investment in societal (ethical, economic, etc.), educational and environmental implications

Increased NNI investments are planned, because of (a) creation of new nanostructures and advancing knowledge; (b) nanotechnology products move to the market; and (c) growth of interdisciplinary societal implication research

a. For societal and educational implications

(Cross-cutting, including contributions from student fellowships).

FY 2004 ~ $45M NSF ($37M+$3M = $40M), DOD ($2M), NIH ($2M), NASA ($1.2M), NIST, EPA

Note: $45M is ~ 4-5% of $960M

b. For nanoscale R&D with relevance to environment/health/safety

(Crosscutting, including env. processes, benign nano-manufacturing, implications)

FY 2004 ~ $95M NSF ($41M), NIH ($33M), EPA ($5M), DOE, USDA, NIST, NASA, NIOSH, FDA

(It includes relevant basics and implications)

Note: $95M is ~ 10% of $960M

($142M including +$47M for NIH health applications)

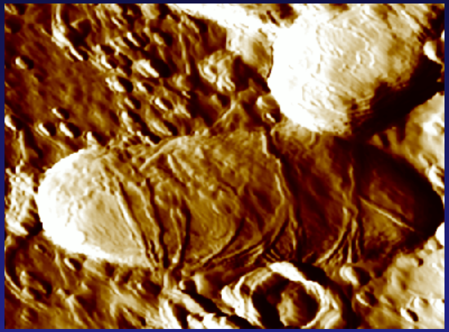
NSF environmental centers and interdisciplinary groups with research and education at the nanoscale

Center (details on www.nsf.gov/home/crssprgm/nano/nni01_03_env.htm)	**Institution**
Fundamental Studies of Nanoparticles Formation in Air Pollution	**Worcester Polytechnic Institute ($2.7M)**
Center for Advanced Materials for Water Purification	**University of Illinois at Urbana ($20.1M)**
Center for Environmentally Responsible Solvents and Processes	**University of North Carolina at Chapel Hill ($25.0M)**
Nanoscience in Biological and Environmental Engineering (estimated 50% in environment)	**Rice University ($11.8M)**
Environmental Molecular Science Institute	**Univ. of Notre Dame ($5M)**
NIRT: Investigating Nano-carbon Particles in the Atmosphere: Formation and Transformation	**University of Utah ($1.7M)**
NIRT: Nanoscale Processes in the Environment - Atmospheric Nanoparticles	**Harvard University ($1.6M)**
Center for Advanced Computational Environment	**SUNY Buffalo ($5.5M)**
NIRT: Nanoscale Sensing Device for Measuring the Supply of Iron to Phytoplankton in Marine Systems	**University of Maine ($0.9M)**

Environmental Molecular Science Institute

Jeremy Fein, University of Notre Dame

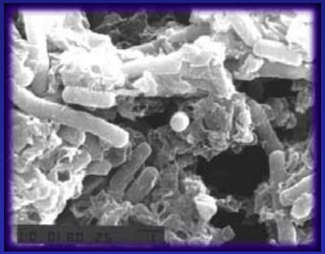
Funding: NSF, DOE



Science/Engineering Projects

***Mission*:** Determine the effects of nano- and micro-particles on heavy metal and radionuclide transport in geologic systems.

-Bacteria
-Natural Organic Matter
-Nanoscale Mineral Aggregates



Education/Outreach Projects

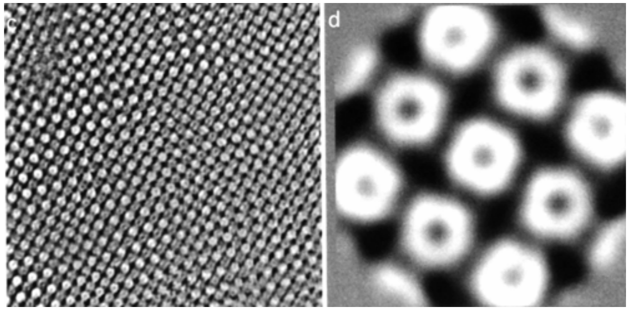
- REU Summer Program
- High School Student Internships
- Active Recruitment of Under-represented Groups with G.E.M.
- National Lab/Industry Internships

National Lab/Industry Partnerships

- Argonne (APS; Actinide Facility)
- Sandia (molecular dynamics modeling)
- Oak Ridge (geomicrobiology)
- DuPont Engineering Technologies

Examples of nano-environmental projects: understanding the implications

- Nanoparticles in the environment
  A. Novrotski, UC Davis (IGERT); U. Kortshagen U Minnesota (IGERT)
- Nano-colloids (metals, actinides) in aquatic systems
  P. Santschi, TAMU (NIRT); JB Fein, Env Molecular Science Institute, UND
- Surface reactivity of nanostructures in environment
  JF Banfiled, UCB; PT Cummins, UVB; MK Ridley, TX Tech Univ (NIRT)
- Application of quantum dots to environment and cell biology,
  AK Sengupta, Lehigh U.
- Molecular Minerals- Microbial interactions in the environment
  M. Nanny, U. Okla.; MF Hochella, U. VA. (NIRT)

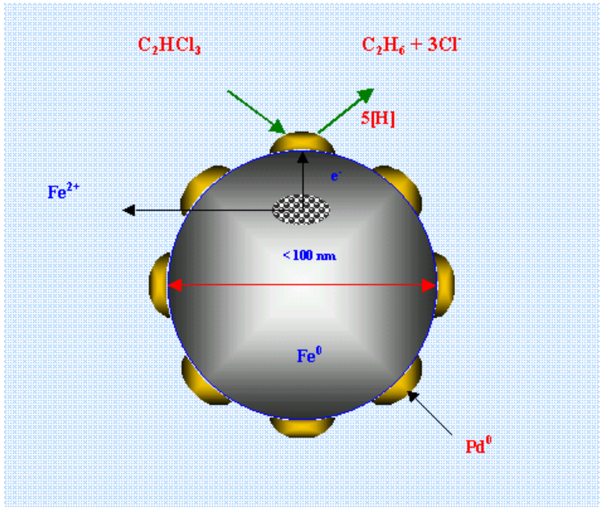


Protein layers of 11 nm diameter by bacteria

- Biological and environmental nanotechnology
  V. Colvin, Rice U. (NSEC)

Examples of nano-environmental research: improving the implications

- Sequestration of volatile organic nanocompounds in environment
  EJ Leboeuf, U. Venderbild (CAREER)
- Nanoscale photocathalyst for destruction of environmental pollutants
  JC Crttenden, MTU (NER)
- Environmental friendly processing of metal oxide suspensions
  RM Davis, VPI



- Nanoscale metal particles: remediation in groundwater
  W. Zhang, Lehigh U. (CAREER)
- Nanobiosensor using dynamic AFM
  JW Schneider, CMU (NER)
- Magnetic separation for environmentally benign processing
  JA Ritter, USC Columbia

NNI projects supporting toxicity research (examples)

Project	Agency, Institution
National Toxicology Program ($0.5M in FY 2004 to $5M in FY 2008)	NIH/NIEHS, FDA/NCTR, NIOSH
Particle characterization for health and safety ($1.7M in FY 2004 rto $2.3M in FY 2005)	NIOSH
Nanotechnology Characterization Laboratory ($5M/yr, part of $144M/yr NCI for FYs 2004-2008)	National Cancer Institute
Multidisciplinary University Research on Nanoparticle Toxicity	Department of Defense supported center
Molecular function at the Nano-Bio Interface (component on nanostructures and cell behavior)	NSF/NSEC U. Pennsylvania
Nanomanufacturing Center for Enabling Tools (component on safe manufacturing)	NSF/NSEC Northeastern University
Size Dependent Neural Translocation of Nanoparticles	NSF/SGER, Rochester University
Reverse Engineering Cellular Pathways from Human Cells Exposed to Nanomaterials	NSF/SGER

NNI projects supporting social implications (examples)

Project	Agency, Institution
Nanotechnology and its Publics	**NSF, Pennsylvania St. U.**
Public Information, and Deliberation in Nanoscience and Nanotechnology Policy (SGER)	**Interagency, North Carolina St. U.**
Social and Ethical Research and Education in Agrifood Nanotechnology (NIRT)	**NSF, Michigan St. U.**
From Laboratory to Society: Developing an Informed Approach to NSE (NIRT)	**NSF, U. of South Carolina**
Social and ethical dimensions of nanotechnology	**NSF, U. Of Virginia**
Undergraduate Exploration of Nanoscience, Applications and Societal Implications (NUE)	**NSF, Michigan Technological U.**
Ethics and belief inside the development of nanotechnology (CAREER)	**NSF, U. Of Virginia**
All centers, NNIN and NCN have a societal implications components	**NSF, DOE, DOD and NIH All nano centers and networks**

National Toxicology Program organization

NTP Director

Dr. K. Olden, Dir NIEHS

Policy Oversight

Executive Committee

ATSDR	NCI/NIH
CPSC	NIEHS/NIH
EPA	OD/NIH
FDA	NIOSH/CDC
NCEH/CDC	OSHA

Environmental Toxicology Program

External Science Oversight and Peer Review

Board of Scientific Counselors

Scientific Advisory Committee On Alternative Toxicological Methods

NIEHS

NCTR
National Center for Toxicological Research
U.S. Food and Drug Administration

NIOSH

Nanotechnology Characterization Laboratory (NCI) Concept of Operations

For comparison and characterization of nanomaterials intended for cancer detection, diagnostics, and therapeutics in humans.

Sources of Nanomaterials

- Cancer Centers of Nanotech Excellence (CCNEs)
- Academia
- NNI
- Small Business
- NCI, NIH, NSF
- DoD, DoE
- Unconventional Innovative Program (UIP)

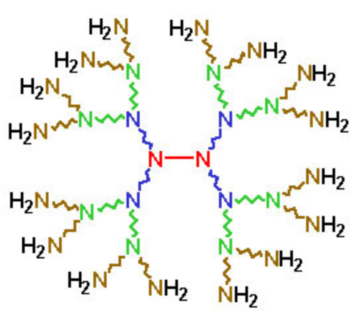
NIST

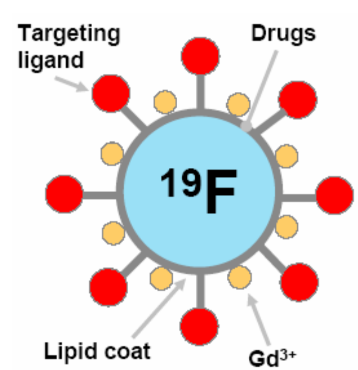
NCL

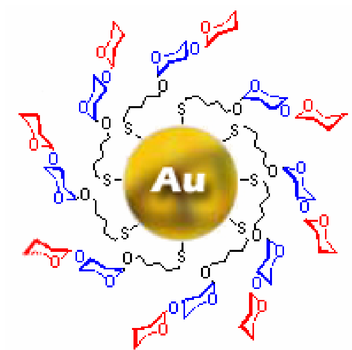
- Physical Characterization
- In Vitro
- In Vivo

- Detection
- Diagnostics
- Therapeutics

Candidate Nanoparticles







B. Existing Regulatory Standards for Ultrafines

Examples in U.S. (1)

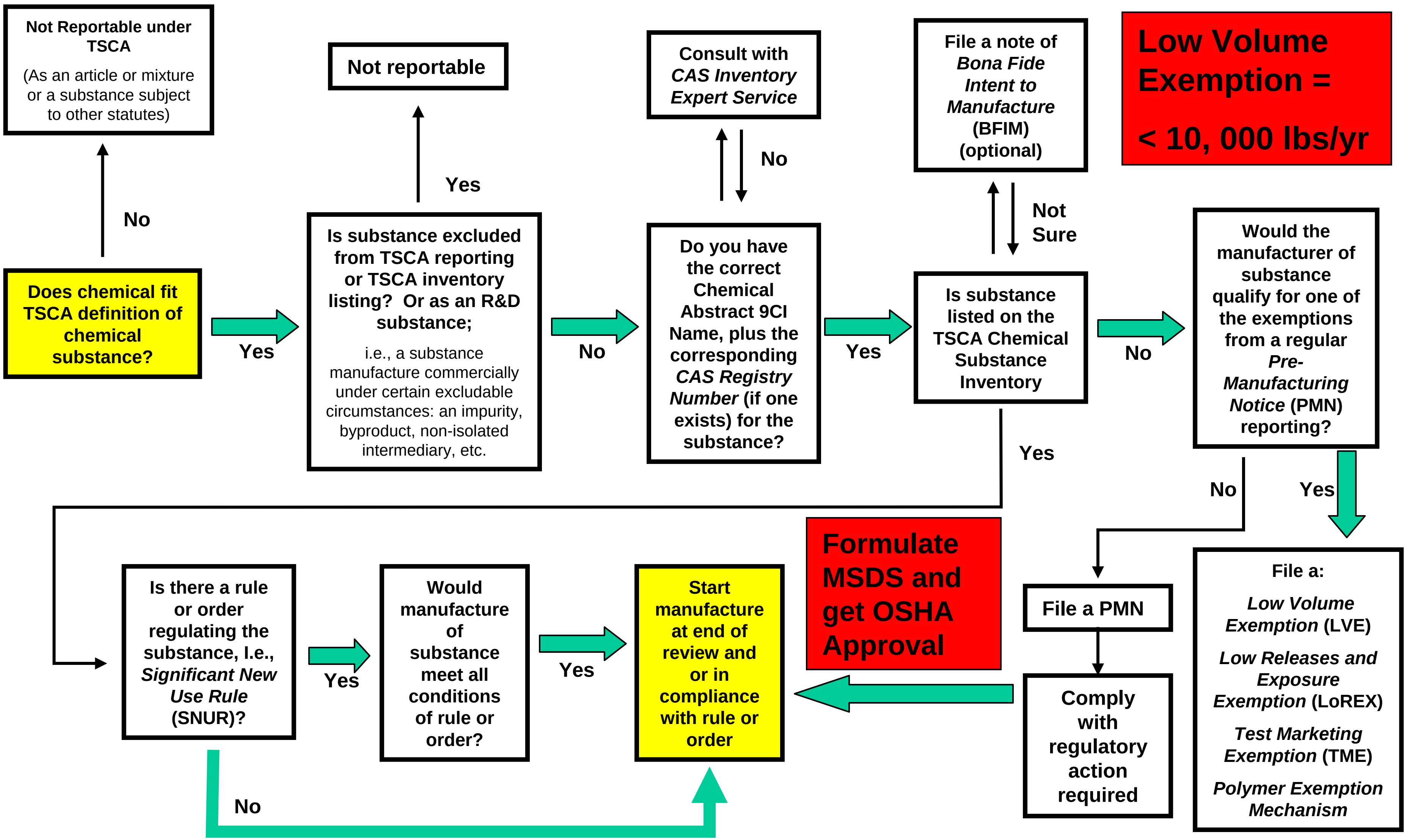
- Particles released into air, water, or soil
  - Toxic Substance Control Act (TSCA) of 1976 – administered by EPA
    - Track over 75,000 chemicals produced or imported into US
  - Regulations for particulate matter < 10 mm (PM10) in force
  - Regulations for particulate matter < 2.5 mm (PM2.5)
    - Put into effect in 1997, data gathering from 1999 to 2003, data analysis and deliberations about regulations underway
- Particles in workplace governed by general aerosols-and colloids- based standards with
  - Recommended exposure limits (RELs) established by NIOSH
  - Permissible exposure limits (PELs) established by OSHA
  - Threshold limit values (TLVs) established by American Conference of Government Industrial Hygienists (ACGIH)
  - Personal protective equipment to reduce exposures set by OSHA and ASTM
  - Based on existing health risk data
  - Targeted at vulnerable regions of the respiratory system

B. Existing Regulatory Standards for Ultrafines

Examples in U.S. (2)

- “Particles” or particle containing materials for drugs to be metabolized by human body – regulated by FDA
  - All “drugs” must have pre-market approval by FDA – called a New Drug Application (NDA); typically approvals take 6-12 months; approval process may require up to several years depending on knowledge level, perceived risk, and clinical trial
  - Burden of proof on FDA to demonstrate health hazard
- “Particles” to be used as diagnostic or therapeutic medical devices – regulated by FDA: Quantum dot – drug if metabolized; device if for diagnostics
- “Particles/substances” to be incorporated into food – FDA and USDA/FSIS share in regulations for food safety:
  - Food additives, food coloring
  - Must have pre-market certification and approval
- Substances incorporated into consumer products – regulated by CPSC under Federal Hazardous Substance Act
  - No pre-market certification or approval
  - Control of use of substance in product determined by risk of exposure

Processing New Chemical Through TSCA



Based on Chart by Ahson Wardak – UVA; Reviewed by EPA

C. Current NNI coordinated measures for EHS

- Develop statement on "Best practices" for research laboratories and industry units (NIOSH, NSF, DOE, NASA, DOD), and identify gaps
- Map of EHS responsibilities and contacts in each NNI agency
- Establish response approach to an unexpected event or an emergency
- Identify protective equipment suitable for nanoparticles and other nanostructured materials (OSHA, NIOSH, other agencies)
- Support development of instrumentation and metrology (NSF, NIST)
- Develop a unified, explicit nomenclature (NSF, ANSI, agencies)
- Develop standards for nanotechnology (ANSI, NIST, IEEE, ASME)
- Collaborative activities with industry (SRC, CCR, Phrma, IRI)
- Identify research and educational needs (Fundamental, GCs)
- <u>NSET Group</u>: "Nanomaterials Environmental and Health Implications"
- <u>OSTP Group</u>: "Risk Assessment of Nanotechnology" task force

D. NNI workshops on nano-environmental research

examples

- NSF, 9/2000: "Societal Implications of Nanoscience and Nanotechnology"
- NSF, 6/2002: "Nanoparticles and the environment" (grantees meeting, book)
- EPA, 11/2003: "Nanotechnology and the environment applications and implications" (grantees meeting, brochure)
- ACS, 3/2003: "Symposium on nanotechnology implications in the environment", New Orleans
- NNI, 5/2003: "Vision for environmental implications and improvement" *(interagency, report)*
- NSET/NNCO, 8/2003: Review of Federal Regulations (report)
- NNI, 9/2003: Interagency : grantees meeting (report);
- Wilson Center, 10/2003: EPA and FDA regulatory functions (report)
- NSET, 12/03 "Societal Implications of Nanoscience and Nanotechnology (II)"

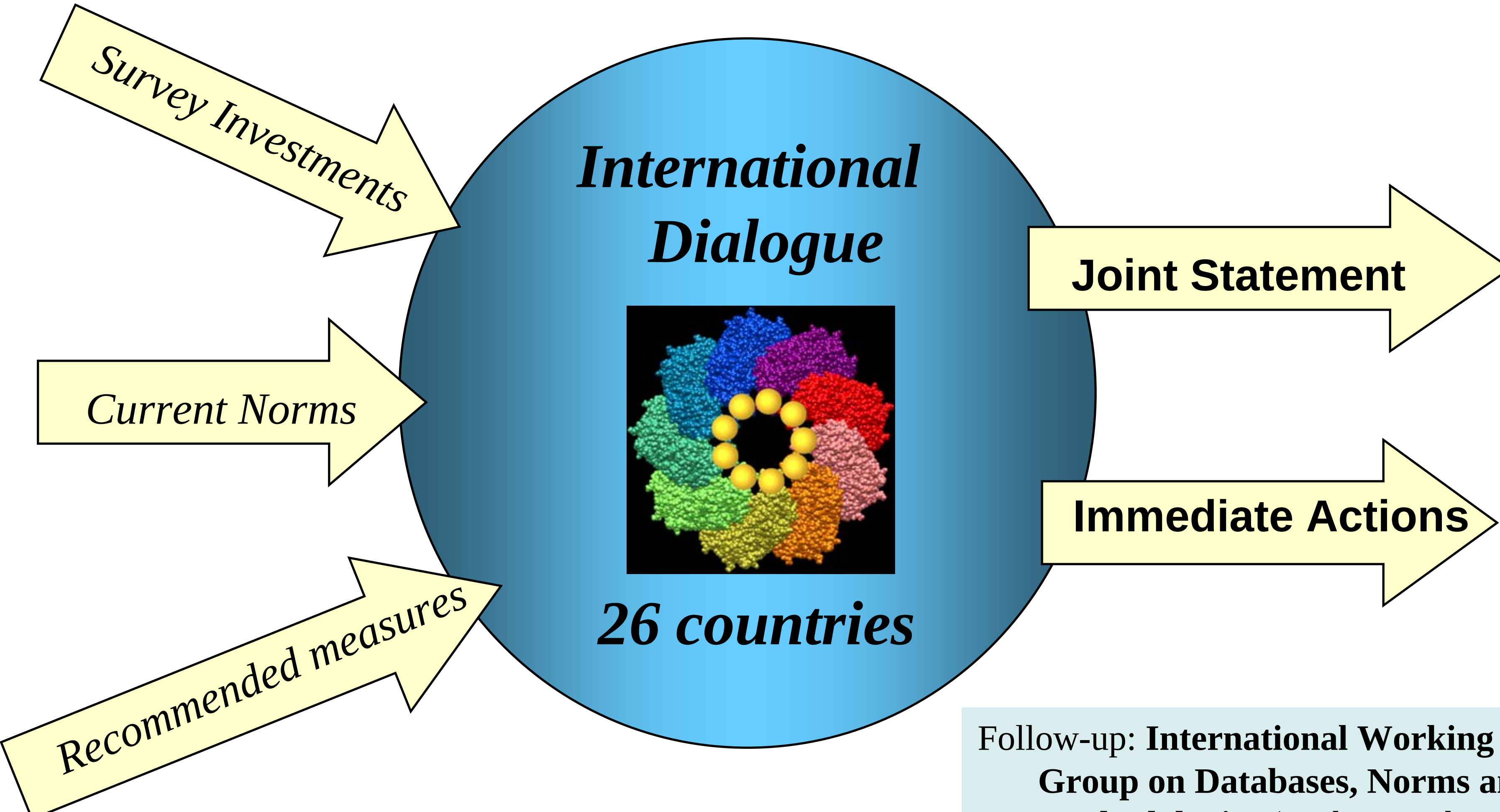
E. International Dialog for Responsible R&D of Nanotechnology

- First meeting on June 17-18, 2004 in Alexandria, VA, US
- Objective: Share information and discuss international collaboration to address responsible development of nanotechnology
- Participants: leaders of the national nanotechnology programs in 26 countries (responding over 30 countries)
- Outcomes:

  - Establish an international consultative board, and a preparatory group to define its future activities.
    Target: set of principles, priorities, and mechanisms

  - Establish immediate exchanges on nomenclature, R&D databases for EHS, standards, and risk assessment methodologies (see link from www.nsf.gov/nano)

International Dialogue on Responsible Nanotechnology R&D



June 2004, Virginia

http://www.nsf.gov/home/crssprgm/nano/dialog.htm

Follow-up: **International Working Group on Databases, Norms and Methodologies** (Barbara Kahn, U.S.; C.K. Lee, Taiwan; Francoise Roure, France; Kasuharu Shimizu, Japan)