NSF Nanotechnology in Society, Network PI meeting

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Research Team, Globalization of Nanotechnology (WG2)

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CNS Global Diffusion Team

Goal: Identify, characterize and analyze the global diffusion of nanoscience and technology

RQ: Where are the emerging hubs of nanoscience? How are they innovating and commercializing in this area?

Research team

Faculty

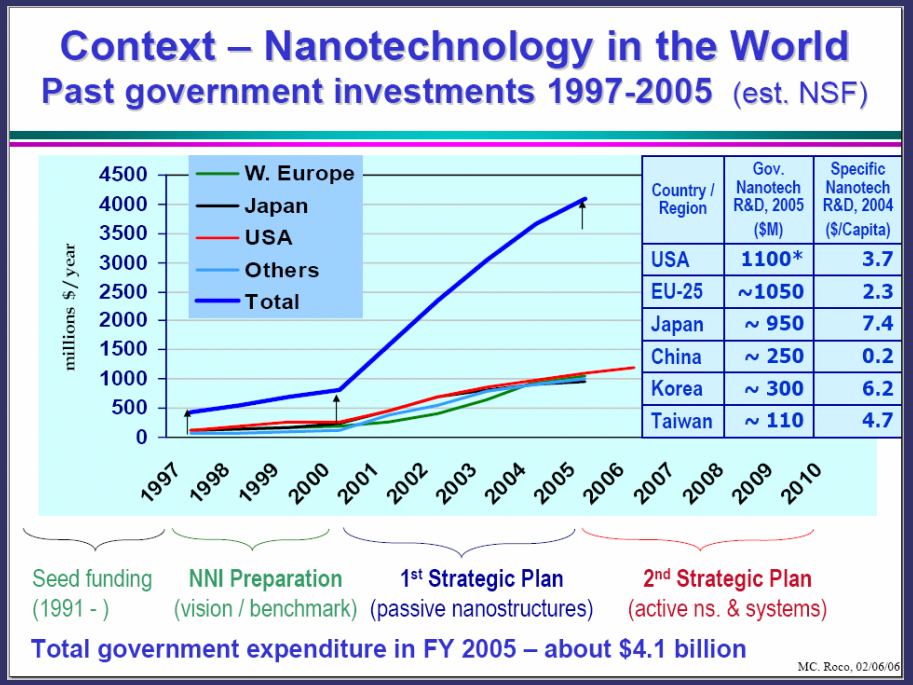
- Rich Appelbaum (UCSB)
- Gary Gereffi (Duke)
- Francesca Bray (Edinburgh)
- Brad Chmelka (UCSB)
- Tim Cheng (UCSB)

Grad / Research Staff

- Rachel Parker, UCSB
- Ryan Ong, Duke

Global Diffusion of Nanotech

- **Governments are investing in R&D**
  - 2005: government funding reached $5 billion globally
  - US National Nanotechnology Initiative: proposed budget of $1.5 trillion for FY 2008
  - Key players: US, Japan, Germany
- **Nanotech growing in developing world.**
  - 2005: China spent more than $250 million on nanotech R&D (Lux)
  - Key players: China, Taiwan, South Korea, Russia



Country / Region	Gov. Nanotech R&D, 2005 ($M)	Specific Nanotech R&D, 2004 ($/Capita)
USA	1100*	3.7
EU-25	~1050	2.3
Japan	~ 950	7.4
China	~ 250	0.2
Korea	~ 300	6.2
Taiwan	~ 110	4.7

Data Sources

- **Secondary:** publications, websites, recent reports
  - Demos, Lux Research, Council on Competitiveness
- **Fieldwork in China:** 30+ interviews with scientists, engineers, and policy-makers (summer 2006):
  - National Center for Nanoscience and Technology (Beijing)
  - Shanghai Nanotechnology Promotion Center
  - Nanotechnology Industrialization Base of China/China National Academy of Nanotechnology & Engineering (Tianjin)
  - Shanghai Jiao Tong, Fudan and Peking Universities
  - Chinese Academy of Sciences (various locations)
  - IMMS, IC-DFN meetings in Shanghai

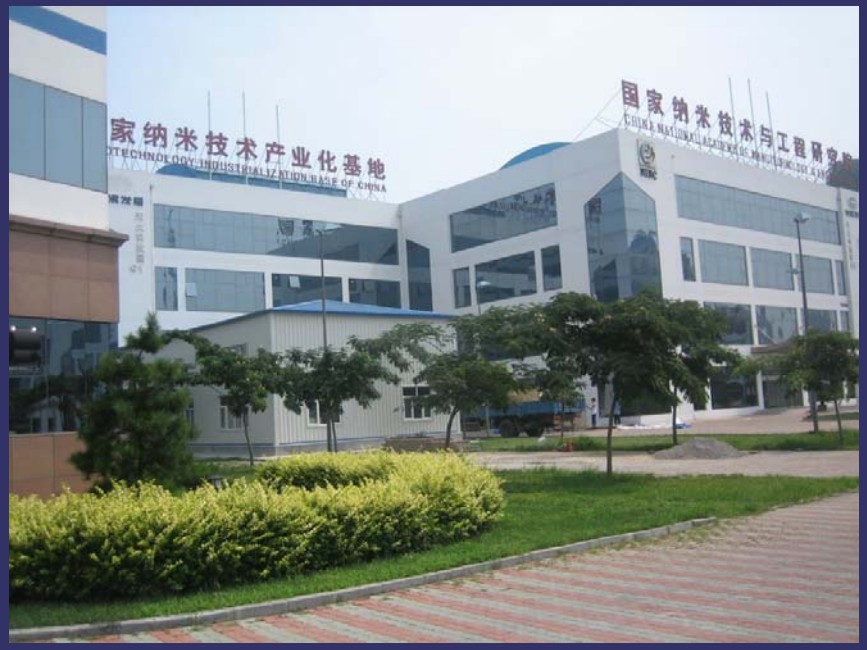
National Nanotech Platforms

- **National Steering Committee for Nanoscience and Technology (2000)** – to oversee national policy and planning
- **National Engineering Research Centers** for nanotechnology
  - Shanghai (SNERC): 10 major shareholders (CAS Institutes, universities, firms, Shanghai Nanotech Promotion Center)
  - Beijing: never got off the ground
- **National Center for Nanoscience and Technology (NCNST)** – Beijing

National Center for Nanoscience and Technology (NCNST)

- **Founded in 2003, under Chinese Academy of Sciences, Tsinghua and Peking Universities**
  - Support from Ministry of Science and Technology, Ministry of Education, and National Development & Reform Commission
- **Primary concerns:**
  - Funding basic research and instrumentation (no product development)
  - Enable collaboration between nanoscientists/engineers
  - Develop common standards for work at the nanoscale
- **Work concentrated in:** nanomaterials/nanostructures, nanomedicine/nanobiotechnology, and nanodevices.

Nanotechnology Industrialization Base of China (NIBC)/China National Academy of Nanotech & Engineering (CNANE)



- **CNANE** and **NIBC** in same facility (Tianjin), same administration
- Funding from Chinese Academy of Sciences, universities, and private enterprise
- **CNANE:** basic research, R&D
- **NIBC:** commercialization; incubator for commercial spin-offs in Beijing metro
- **Potential applications:** novel materials, medical diagnostics/treatment, drug delivery, new (lighter) aircraft, cleaner energy, air/water filtration

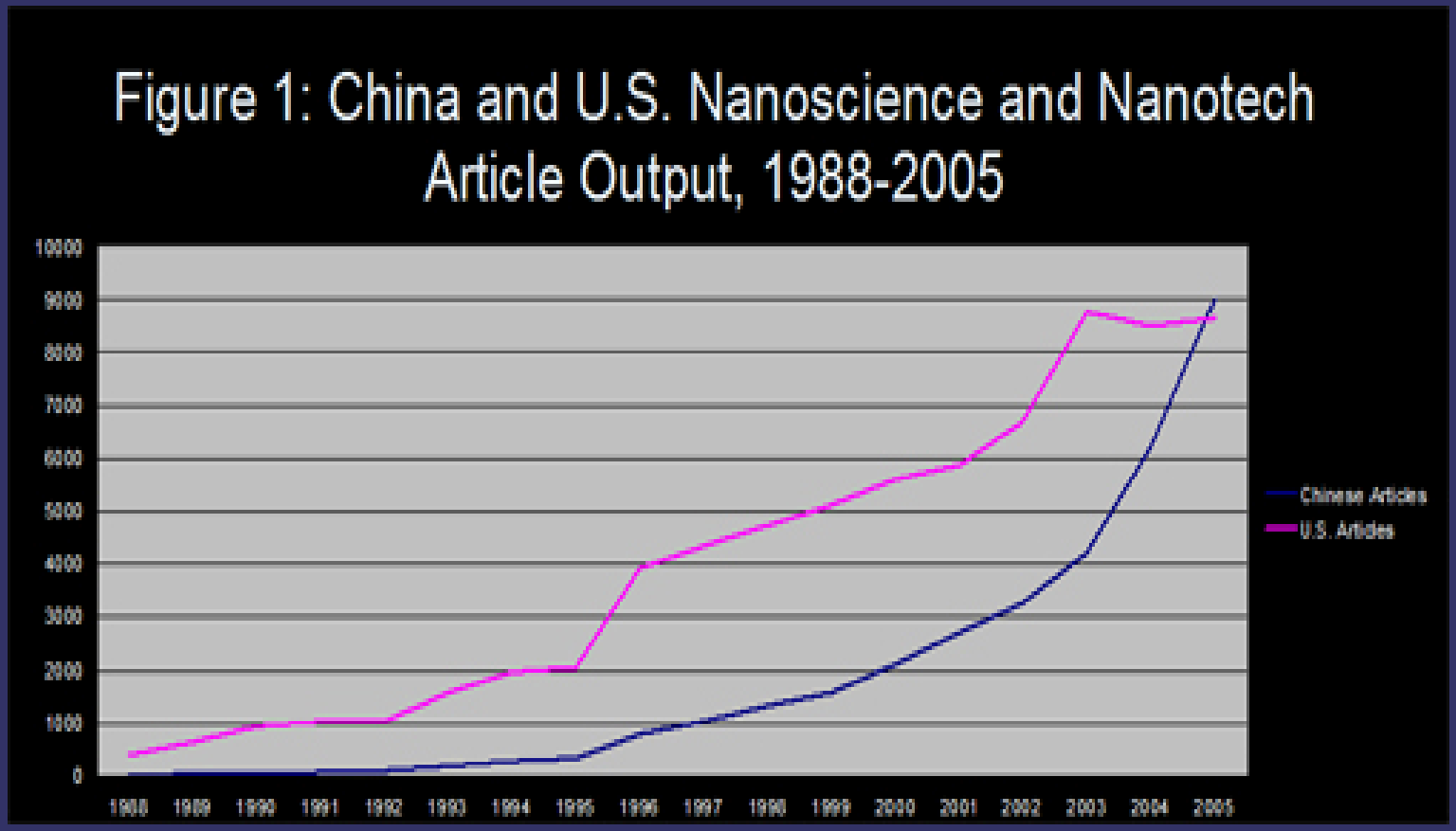
Commercialization in China: Areas of Progress

- **Self-cleaning glass:** Beijing Concert Hall
- **"Nano-refrigerators"** with interior coatings that absorb odors
- **Air conditioners** that filter out organic materials
- **Conductive and anti-corrosive coatings** for oil tanks (Shenzhen Nanotech Port Company)
- **Pavement coatings** that filter out vehicle exhaust (Olympic venue parking lots)

Commercialization in China: Areas of Weakness

- **Commercialization remains limited**: nanotech largely in R&D phase
  - Progress impeded by state-managed industries wary of innovations with long-term ROI (15+ years away?)
- **Intellectual property issues/protections**
- **Pressure to produce/publish** (quality, fraud)
- **Limited infrastructure** (e.g., nano fabrication facilities); inadequate funding
- **Inadequate funding**: limited government funding; lack of private venture capital

Nanotech Publications Are Growing…



source: CNS analysis of database of more than 14,000 nanotechnology articles in 81 high-impact science and engineering journals

…but impact is still weak.

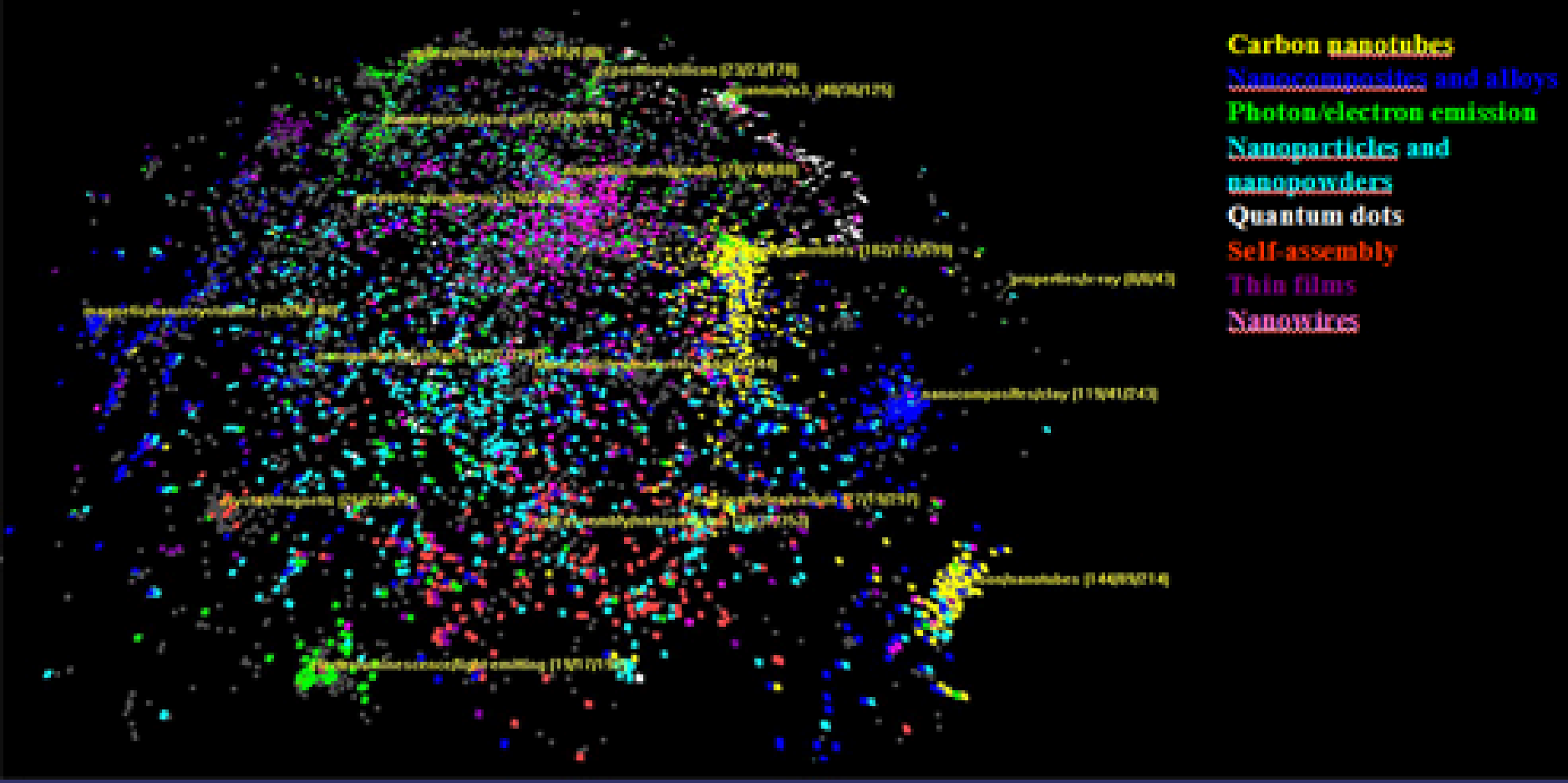
- **Citations Per Paper, 2001-2003**
  - China: 2.28
  - Japan: 3.70
  - Germany: 4.54
  - United States: 6.56
- **Is this number rising?**

Source: Bai Chunli, *Science* July 2005

Weaknesses of China's Nanoscience

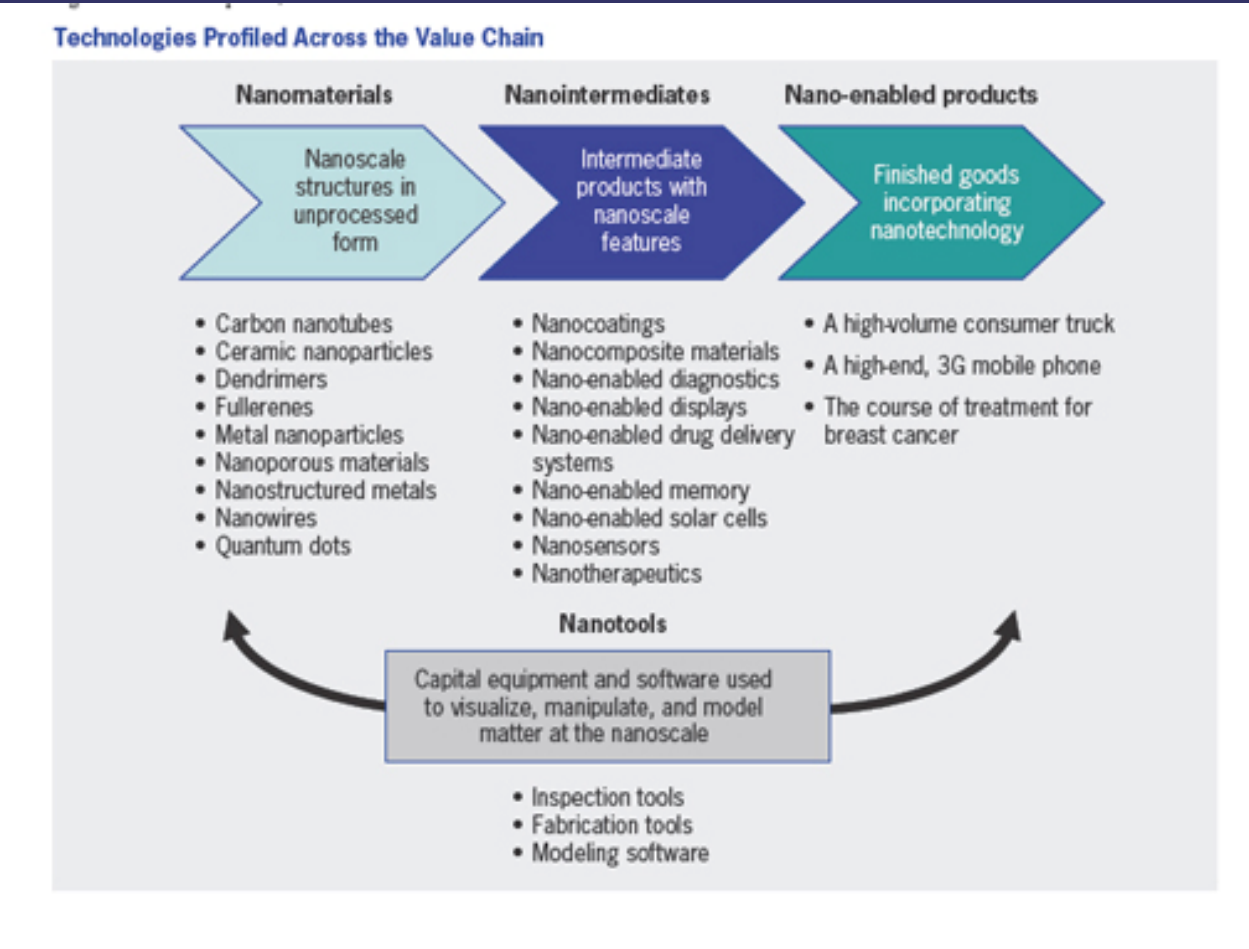
- imitation, rather than innovation
- intellectual property issues/protections
- pressure to publish
- limited infrastructure (e.g., nano fabrication facilities)
- inadequate spending

Figure 2: Landscape of Chinese Nanoscience 2003-2005



source: CNS analysis of shared citations

Nanotech Value Chain



Source: Lux Research, *The Nanotech Report, vol. 1,* 4th edition (2006)

CNS Innovation Team (WG2)

Goal: Optimize sustainable innovation and its policy framework for nanotechnologies

RQ: How is nanoscale R & D changing the existing innovation system?

Research team

Faculty

- Chris Newfield (UCSB)
- Dave Seibold (UCSB)
- Suzanne Scotchmer (UCB)
- David Mowery (UCB)
- Gerald Barnett (UCSC)

CNS Grad Fellows

- Kim Stoltzfus, Comm
- Aaron Rowe, Chem
- Jerry Macala, Chem
- Alan Glennon, Geog

WG2-Innovation Research

Years 1-2 Projects: Nanoscale Innovation Flows

- **Mapping the Nano-Enterprise**. West Coast -> Pacific Rim; university-industry emphasis; new enterprises
- **Strong and Weak Innovation Currents**: Where is technology moving well? What helps and hurts this movement? *Interviews with nanoscale participants (PIs, Tech Managers, grads, industry)*
- **Improving Innovation Climate**: beyond transfer, how do we fund, build and sustain "multi-local" research communities? *Policy research combined with lab field study*.

WG2 Innovation Team: Mapping California Nano-enterprises