

# NSE Centers and Industry Partnerships

## *Moderators*

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## *Panelists*

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*NSF NSE Conference, Dec 7, 2009*

*Tuominen, 12/7/09*

# Important Points of Discussion Today

- Mechanisms of Interaction
- Networking
- Examples of Spin-off Companies
- Progress at the "speed of business"

# Nanomanufacturing & Commercialization

**What issues are particularly unique about nanomanufacturing, at this point in time?**

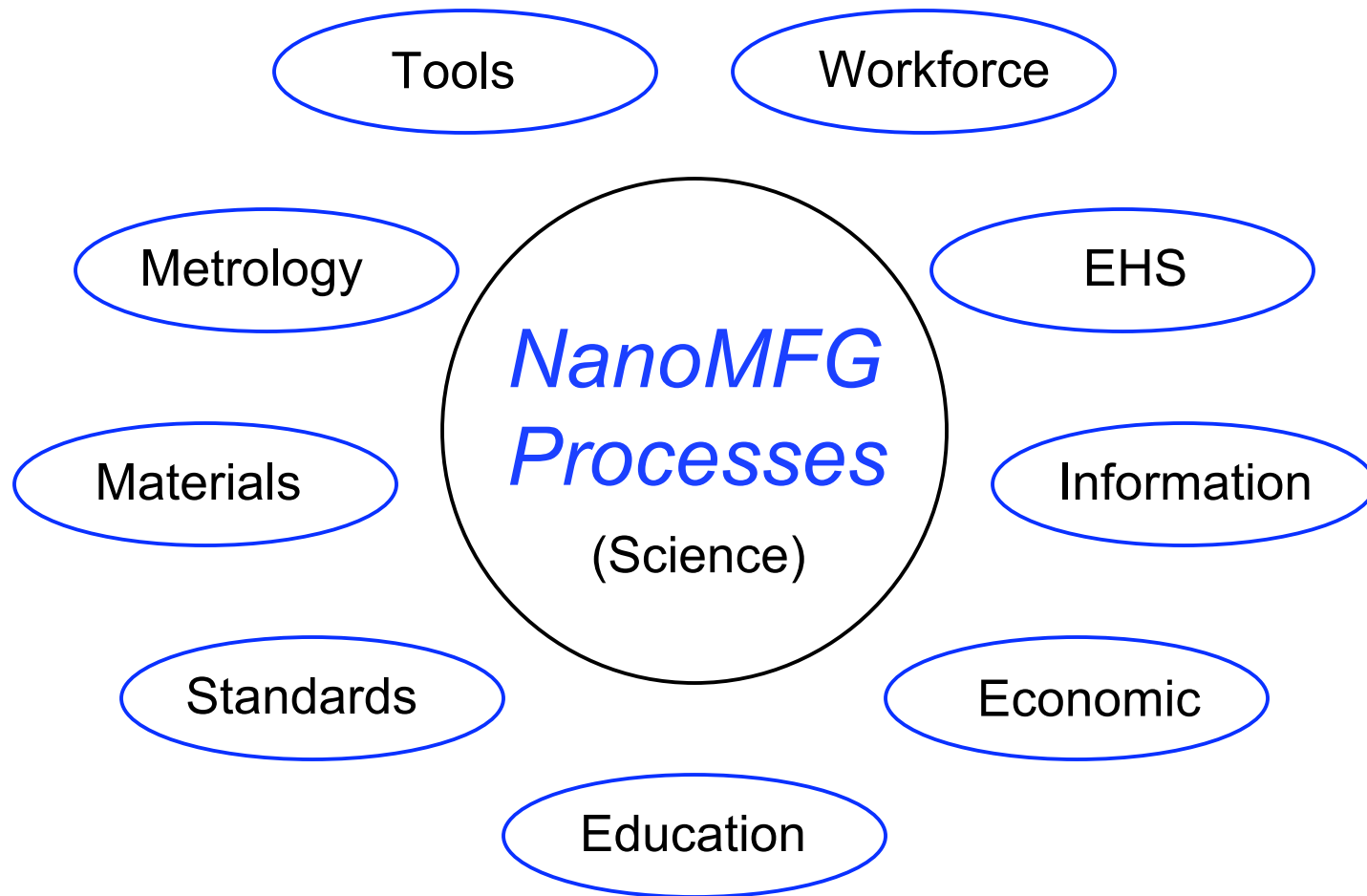
- Many promising nanomfg process methods are new
- Open innovation needed more than ever before
- In many cases, materials properties data lacking robust certification
- EHS is requiring extra attention
- Infrastructure (physical and intellectual) for nanomfg has gaps that limit development

**Information • Tools • Know-how • Roadmaps**

# NSF Centers Can and Do Play a Vital Role

- Basic research: Exploration and discovery
- Education and training of workforce
- Creation of scientific data and knowledge
- Innovation of enabling technologies
- Focal point of communication and dissemination
- Expert base for development of standards and policy
- Innovations in efficiency and optimization

# Nanomanufacturing System





An open access network for the advancement of ***nanomanufacturing*** R&D and education

- Cooperative activities (*real-space*)
- Information clearinghouse (*cyber-space*) [InterNano](#)

***Mission: A catalyst to support and develop communities of practice in nanomanufacturing. A partnership between academia, industry and government.***

[www.nanomanufacturing.org](http://www.nanomanufacturing.org)

# Origins of the NNN: Four Nanomanufacturing NSF NSECs

- **Center for Hierarchical Manufacturing (CHM)**
  - UMass Amherst/UPR/MHC/Binghamton



- **Center for High-Rate Nanomanufacturing (CHN)**
  - Northeastern/UMass Lowell/UNH



- **Center for Scalable and Integrated Nanomanufacturing (SINAM)**
  - UC Berkeley/UCLA/UCSD/Stanford/UNC Charlotte



- **Center for Nanoscale Chemical-Electrical-Mechanical Manufacturing Systems (Nano-CEMMS)**
  - UIUC/CalTech/NC A&T



## Nanomanufacturing Technology for Biomedical Applications

### Highlights

Written by InterNano

October 06, 2009



If you need a reason to register for the upcoming US/Ireland Emerging Technologies Conference, their program session on nanomanufacturing for biomedical applications should be enough.

[Read more...](#)

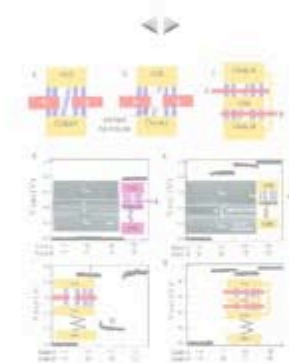
## Better Control of Carbon Nanotube Growth Promising for Future Electronics

### Press Releases

Written by Emil Venera, Purdue University

October 05, 2009

Researchers have overcome a major obstacle in efforts to use tiny structures called carbon nanotubes to create a new class of electronics that would be faster and smaller than conventional silicon-based transistors. Carbon nanotubes, which were discovered in the early 1990s, could make possible more powerful, compact and energy-efficient computers, as well as ultra-thin "nanowires" for electronic circuits. The nanotubes might be ideal for future electronics because they conduct electricity more efficiently than any other metal, but their practical application requires that they be manufactured to specific standards.



Ryu Figure 4

PMOS NOR and NAND gates with top-gated transistors. Examples of defect tolerant designs are b) and c). [Read more](#)



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# Nanomanufacturing Infrastructure: Physical and Intellectual

**Information • Tools • Know-how • Roadmaps**

**Information** - *enabling product design and manufacturing design*

- Nanomanufacturing process-property relationships
- Nanomaterial properties data - with statistics and metadata
- Experts and facilities
- Suppliers of materials and tools
- Documentary standards
- Data curation
- Federation of data and information

# continued

## **Tools** - *enabling commercial scale production*

- Scalable tool development for emergent nanomfg processes
- Nanomfg process control technology - measurement & control
- A high level of automation
- Standard reference materials
- Nanoinformatics tools - search, model, design, evaluate

## **Know-how** - *enabling manufacturing craftsmanship and innovation*

- Training of students in nanomanufacturing science and engineering
- Professional development of technicians and engineers
- Innovation and technology management best practices

## **Roadmaps** - *enabling the way forward by pooling resources and expertise*

- Topical clusters/Industry clusters -- "all politics is local"
- SEMATECH-like model for other nanomanufacturing cluster areas
- Communicating industry needs to academic and government scientists
- Culture of sustainable manufacturing

## Taxonomy: Nanomanufacturing Processes

- General Terms
- Assembly Techniques
- Biological Techniques
- Bulk (Nano)Material Synthesis Methods
- Deposition Methods
- Etching Methods
- Nanocomposite Manufacturing Methods
- Nanoparticle Synthesis
- Nanopatterning Lithography
- Roll-to-roll Manufacturing Techniques
- Self-Assembly and Directed Self-Assembly

## Standards: ISO TC 229 (Joint with IEC 113)

### Project Group 10:

#### Nanomanufacturing Terminology and Definitions

- Based on *InterNano* nanomanufacturing process taxonomy (ANSI) and BSI nanofabrication PAS 135
- Creates a master taxonomy in nanomanufacturing
- Framework accommodates new process terms
- Feeds back into InterNano

Argentina, Belgium, Canada, China, Finland, Germany, Iran, Italy, Japan, Korea, Malaysia, Mexico, Netherlands, Portugal, Romania, Russia, Singapore, South Africa, Spain, Switzerland, Thailand, USA (co-lead), UK (co-lead)