

InterNano

Resources for Nanomanufacturing

a project of  National
Nanomanufacturing
Network

Jeff Morse

Managing Director

National Nanomanufacturing Network

Center for Hierarchical Manufacturing

University of Massachusetts Amherst

jdmorse@research.umass.edu

 National
Nanomanufacturing
Network

InterNano

National Nanomanufacturing Network and InterNano

Establish a network of experts and stakeholders to identify challenges, solutions, and approaches for a nanomanufacturing roadmap

A catalyst for nanomanufacturing R & D advancement in the US via:

- Cooperative activities (workshops, conference, initiatives)
- An information clearinghouse (InterNano)

To support, and help launch, communities of practice in nanomanufacturing in both real and cyber space

Mark Tuominen - Director of NNN

Jeff Morse - Managing Director of NNN

Blake Spitz - Project Manager of InterNano (2014)

Robert Stevens – Web Development



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Center for Hierarchical Manufacturing UMass Amherst

NSF Nanoscale Science
and Engineering Center
2006-2016

James Watkins-Director, Mark Tuominen-Co-Director

Snapshot:

- An NSF Nanoscale Science and Engineering Center
 - Funded through NSF's Division of Civil, Mechanical and Manufacturing Innovation
- \$4 million/year in NSF Support
 - The CHM is funded by NSF through 2016
- 39 Faculty in 8 disciplines at 6 Institutions (27 Faculty at UMass)
 - UMass Amherst (Lead Institute), Michigan, MIT, Rice, Indiana, Mt. Holyoke, Puerto Rico, Springfield Technical Community College

National Nanomanufacturing Network

- In addition to its own research program, the Center for Hierarchical Manufacturing manages the National Nanomanufacturing Network, providing the nanomanufacturing R&D community with technical information, workshops, and technology roadmaps.



www.r2rnano.org



www.internano.org

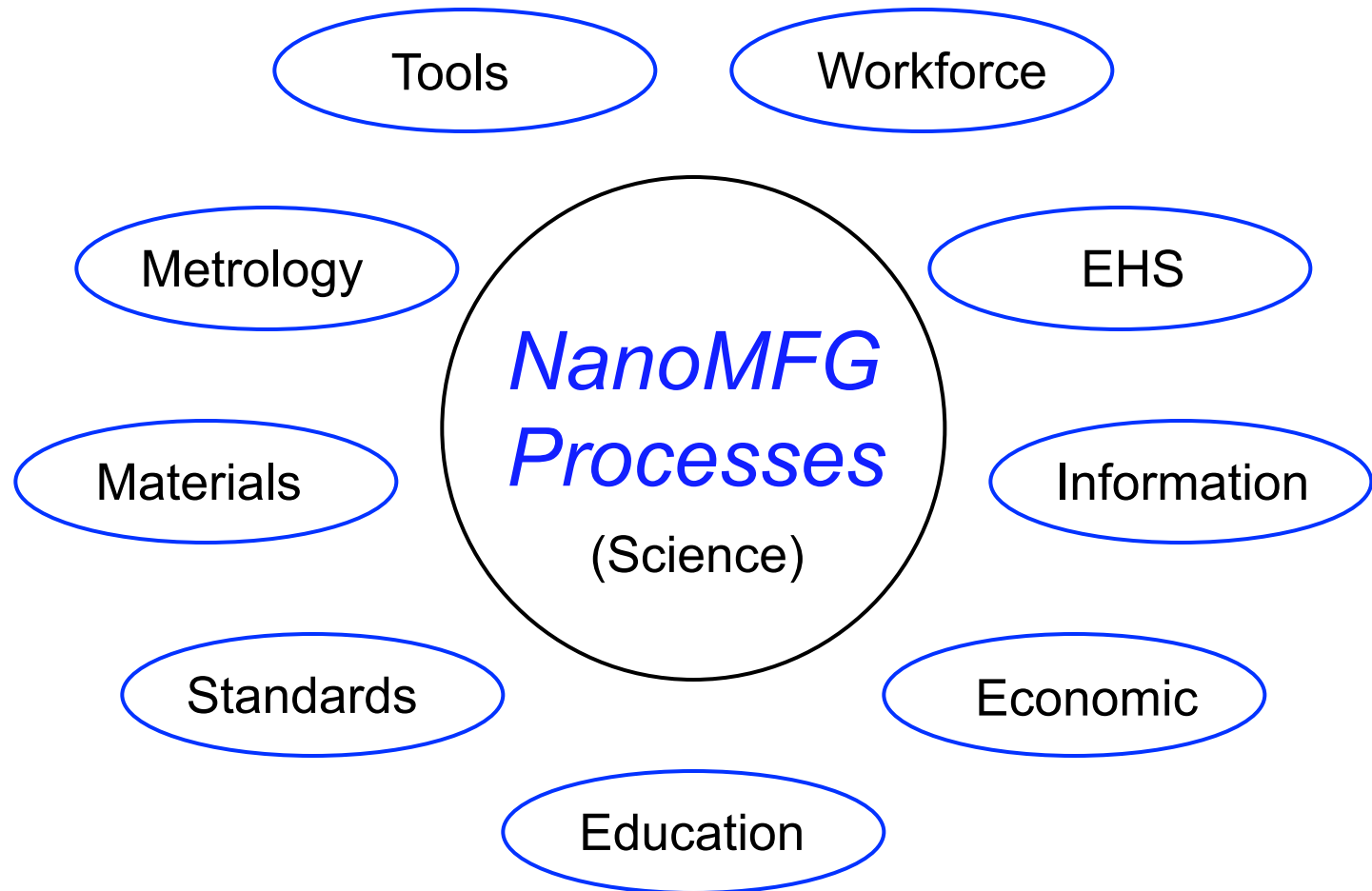
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NNN: Key Partners and Affiliates

- **Center for Hierarchical Manufacturing (CHM)**
 - UMass Amherst/UPR/MHC/MIT/Rice/Binghamton
- **Center for High-Rate Nanomanufacturing (CHN)**
 - Northeastern/UMass Lowell/UNH
- **Center for Scalable and Integrated Nanomanufacturing (SINAM)**
 - UC Berkeley/UCLA/NWU/UCSD/Stanford/UNC Charlotte
- **Center for Nanoscale Chemical-Electrical-Mechanical Manufacturing Systems (Nano-CEMMS)**
 - UIUC/CalTech/NC A&T
- **Center for Integrated Nanotechnologies (CINT)**
 - Sandia National Laboratories
- **Center for Nanoscale Science and Technology (CNST)**
 - NIST



Needed Nanomanufacturing Infrastructure: Physical and Intellectual



Information • Tools • Know-how • Roadmaps



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Example NNN Outreach Activities

- **Special Initiatives Supporting Nanomanufacturing Infrastructure**
 - Lead ISO TC 229 standards project on "Terminology and Definitions for Nanomanufacturing Processes" –Completed Dec 2013
 - Major contributor to activities on a U.S. nanoinformatics roadmap
 - Board of Advisors – NanoBusiness & Commercialization Association (NanoBCA)
Graphene Stakeholders Association (GSA)
- **NNN Workshops and Conferences**
 - US-EU Workshop on Nanofabrication Technologies for Scaled Roll-to-Roll and Print Manufacturing (Oct 23-24, 2013 Barcelona)
 - Nanoinformatics 2013 (October 15, 2013, Philadelphia, PA)
 - Nanomanufacturing Summit 2013 (October 15-17, 2013, Philadelphia, PA)
- **Nanomanufacturing-specific education and training initiatives**
 - Short course at Flexible Electronics 2014 on R2R Nanomanufacturing
 - Short course for Materials Research Society Fall Symposium 2014 on R2R Nanomanufacturing
- **Community Outreach**
 - Participant monthly NanoBCA telecon with NNCO
 - Weekly mailer and monthly newsletter
 - Co-organized NM Summit 2013 with NanoBCA



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InterNano: the online information service of the NNN

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Exploratory Nanoinformatics meeting
(June 2007)

2009 Nanomanufacturing Summit Panel
(May 2009)

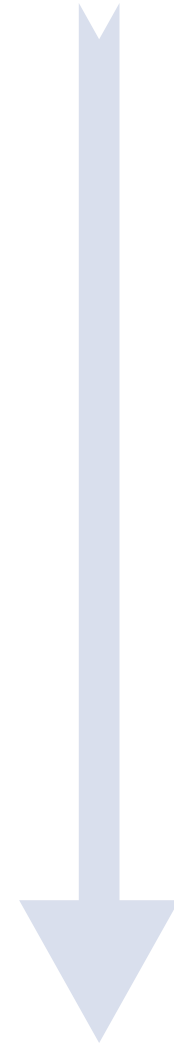
Nanoinformatics 2010
(November 2010)

Nanoinformatics 2020 Roadmap Published
(April 2011)

Nanoinformatics 2011: Q-SARs and MinChar
(December 2011)

**Nanoinformatics 2012 Summer Workshop:
Tools and Resources**
(July 2012)

**Informatics for Nanomanufacturing
Workshop** (October 2013)



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Scope

- nanomanufacturing processes
- tools for nanomanufacturing
- nanoscale objects and nanostructured materials
- nanomanufacturing characterization techniques
- environmental, health and safety considerations for nanomanufacturing
- social and economic implications of nanomanufacturing
- informatics and standards for nanomanufacturing
- commercialization, regulation and intellectual property



The screenshot shows the InterNano website interface. At the top, the logo "InterNano Resources for Nanomanufacturing" is displayed alongside the National Nanomanufacturing Network logo. A search bar is located on the right. Below the header, a navigation bar includes links for "For Researchers", "For Industry", "Resources", "Events", "News", "About", and "Login". Social media icons for Facebook, LinkedIn, Twitter, and RSS are also present.

The main content area is organized into several sections:

- Browse by Subject:** Includes a circular diagram icon.
- Expert Reviews:** Includes an icon with a person and a document.
- Highlights:** Includes an icon of a microscope.
- Processes:** Includes an icon of a textured surface.
- Regional State Local Initiatives in Nanotechnology:** Includes a map of the United States.
- Nanoscale Science and Engineering Centers:** Includes the NSF logo.
- User Facilities:** Includes an icon of a laboratory setting.
- Directory:** Includes the Optofluidics logo.
- Library:** Includes an icon of a bookshelf.
- Calendar:** Includes an icon of a calendar.

A featured article titled "Virtual Design Methods Provide Strategy for Innovation through Nanomaterial Database Development" is highlighted, with a sub-section for "Expert Reviews". The article discusses the establishment of open-access, federated databases for materials properties and the use of computational models to predict material behavior.

An orange box titled "What is Nanomanufacturing?" provides a definition: "Nanomanufacturing is the essential bridge between the discoveries of the nano sciences and real-world nanotechnology-enabled products." It includes a "Read more..." link.

The "Industry News" section lists several recent developments:

- 'White graphene' halts rust in high temps: Rice U. researchers find nano-thin films of hexagonal boron nitride protect materials from oxidizing
- Strategic Business Report on Global Market for Nanoencapsulation for Food Products
- Nanofibre Production Device from Contipro New Lab Showroom
- Berkeley Lab, UC Berkeley Dedicate New Energy Nanosciences Institute
- Cambios Collaborative Venture to Produce ClearOhm Silver Nanowire-Based Film for Advanced Touchscreens
- Graphene industry to focus on low hanging fruits

Process Database



Resources for Nanomanufacturing

a project of 

Search

For Researchers | For Industry | Resources | Events | News | About | Login

Home > Resources > Process Database > Browse Processes > Process Description #66

66. Aligned Carbon Nanotube Patterning Via Dry Contact Transfer Printing

The approach of transferring CNT thin films from one surface to another via a soft lithography technique suffers from limited ability to achieve good adhesion of the CNT films to the transferred substrate and imprecise alignment of the CNT patterns. A transfer technique that can be scaled to large area with high throughput processing at low temperature is being reported in this paper, demonstrating a scalable means to create aligned CNT thin film patterns on both rigid and flexible substrates.

Contributors: Pint CL, Xu YQ, Moghazy S, Cherukuri T, Alvarez NT, Haroz EH, Mahzooni S, Doorn SK, Kono J, Pasquali M, and Hague RH

Deposited by: Amulya Gullapalli

Manufactured Nanomaterial or Structure: CNT's patterning

Process:

- Lithographic patterning of wafer-scale traces of Al_2O_3 (10 nm thick) followed by 0.5 nm of Fe catalyst.
- Growth is and diam...
- This is fo between der Waals
- Transfer i substrate arrays.



Notes: A key eliminating...

Equipment R...

- Chemice

References:

(a) Scheme depicting the process for dry contact transfer of aligned SWNTs as described in the text. (b) SEM image of an upright patterned growth prior to transfer, and (c) picture showing a complete transfer to a 5 mm x 5 mm wide diamond window.

Pint CL, Xu YQ, Moghazy S, Cherukuri T, Alvarez NT, Haroz EH, Mahzooni S, Doorn SK, Kono J, Pasquali M, and Hague RH. 2010. Dry contact transfer printing of aligned carbon nanotube patterns and characterization of their optical properties for diameter distribution and alignment. ACS Nano 4(2): 1131-1145.



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Tags: Carbon nanotubes, Nanopatterning/Lithography, Nanotubes, Thin films

DOI: 10.4053/pr066-130307



Views: 231

NNN Newsletter



National Nanomanufacturing Network

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Newsletter

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Alternative Test Strategies, Predictive Models to Assist Nanomaterials Safety Assessment



With the exponential growth of engineered nanomaterials (ENMs) extending from research and development to commercial products, the daunting challenge of conducting effective risk assessment and life-cycle analysis for these materials is presented. Of primary concern is the potential for human exposure that may lead to adverse outcomes, which traditionally utilizes animal studies and specific protocols to identify exposure risks. With increasing emphasis on understanding the basis for adverse outcomes, numerous approaches incorporating predictive modeling combined with expanded *in vitro* and short term *in vivo* studies have fostered a conceptual shift in toxicological studies of ENMs.

Driven by advances in chemical testing methodologies, a new paradigm for understanding exposure risks for ENMs will combine high throughput screening (HTS), high content screening (HCS), and predictive modeling to significantly reduce the reliance on animal studies while increasing the rate of data driven knowledge and the understanding of nanomaterials. While this should draw a collective sigh of relief from government regulators and industry alike, specific data are limited to establish effective policies for risk assessment covering emerging ENMs without the need for further extensive studies and financial burdens.

More...

New Grayscale Technique Opens a Third Dimension for Nanoscale Lithography



Engineers at the NIST Center for Nanoscale Science and Technology (CNST) have developed a new technique for fabricating high aspect ratio three-dimensional (3D) nanostructures over large device areas using a combination of electron beam (e-beam) lithography, photolithography, and resist spray coating. While it has long been possible to make complicated 3D

August 2013

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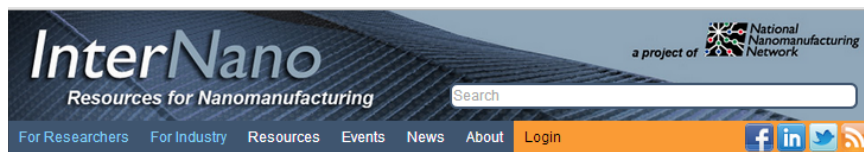
 

Process Database | Calendar

Expert Reviews

Directory



Home » Resources » Expert Reviews » Virtual Design Methods Provide Strategy for Innovation through Nanomaterial Database Development

Virtual Design Methods Provide Strategy for Innovation through Nanomaterial Database Development

Written by Jeff Morse, PhD
September 26, 2013

Recent materials informatics initiatives are fostering the establishment of open-access, federated databases that catalogue the properties of materials. While an initial emphasis, particularly in the case of nanomaterials, is to understand the toxicological properties of materials, a key goal is to establish model-based materials design methodologies wherein materials properties can be computationally predicted. Such a virtual design approach to materials represents a powerful paradigm in which tools become openly available to design new products, optimize materials performance, and understand the risk associated with human and environmental exposure before the materials has been synthesized. Such an infrastructure will benefit industry, academia, and government agencies alike in providing low cost, rapid turn-around approaches to design, and manufacture materials, incorporate into product designs, and establish the regulatory pathway for workforce and consumer protection.

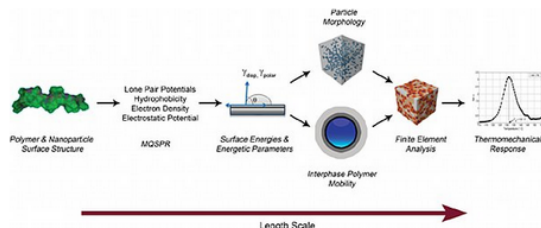
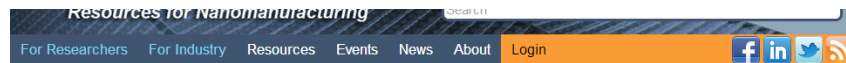
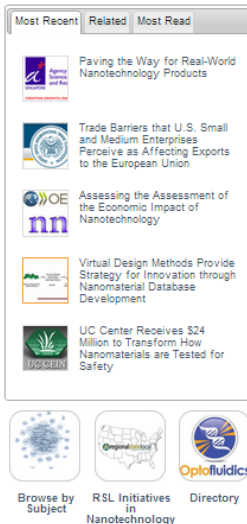


Figure 1. A schematic showing the genomics approach to predicting the thermomechanical response.

From left to right shows: MQSPR is used to relate the polymer and nanoparticle surface structure to the polar and dispersive components of the polymer and nanoparticle surface energy. The surface energies are then used to quantitatively predict the dispersion state of the nanoparticles and the properties of the filler/polymer interface. Using Finite Element Analysis (FEA), the microstructure is reconstructed and the filler, polymer, and interphase properties used as input. The FEA provides an a-priori prediction of the thermomechanical properties from MQSPR calculated surface energies.

While this scenario presents a futuristic vision, the necessary steps in this direction are being taken with the establishment of the Materials Genome Initiative and the Nanoinformatics initiatives, which include activities in areas such as materials database development, data mining tools, and materials design for manufacturing virtual tools. A prime example of implementation of materials design tools was recently reported by Breneman, et. al. in which a data-driven approach to the virtual design of nanostructured polymers was introduced. In this work, the authors implemented materials quantitative structure-property relationship (MQSPR) models to develop a numerical analysis approach to predict the thermomechanical properties of spherical nanofilled polymer composites. The model was validated through a systematic investigation of silica nanoparticles having three different surface chemistries in several polymers.

The work reported is the first time that the MQSPR technique has been utilized across multiple length scales providing the connection between underlying chemistry of the polymer and nanoparticle surface, physics of nanoparticle composite dispersion, and bulk properties of resulting materials. In addition, this approach can further determine the compatibility between the polymer and nanoparticle materials. In combining the MQSPR



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nanometrics Nanometrics Incorporated
sales@nanometrics.com

Mailing Address ☐

1550 Buckeye Drive
Milpitas, CA, 95035
USA
408-545-6000
map

Nanometrics is a leading provider of advanced, high-performance process control metrology and inspection systems used primarily in the fabrication of semiconductors and other solid-state devices, such as data storage components and discretely including high-brightness LEDs and power management components. Nanometrics' automated and integrated metrology systems measure critical dimensions, device structures, overlay registration, topography and various thin film properties, including film thickness as well as optical, electrical and material properties. The company's process control solutions are deployed throughout the fabrication process, from front-end-of-line substrate manufacturing, to high-volume production of semiconductors and other devices, to advanced wafer-scale packaging applications. Nanometrics' systems enable advanced process control for device manufacturers, providing improved device yield at reduced manufacturing cycle time, supporting the accelerated product life cycles in the semiconductor market.

Nanometrics was incorporated in California in 1975. Nanometrics has been publicly traded since 1984 and is listed on NASDAQ (NANO). We have been a pioneer and innovator in the field of optical metrology. Nanometrics has an extensive installed base of more than 6,500 systems in over 150 production factories worldwide. Our major customers and original equipment manufacturer (OEM) partners include the largest semiconductor and process equipment manufacturers in the world.

Tags: high-performance process control metrology, Metrology, inspection systems, Semiconductors, solid-state devices, data storage, high-brightness LEDs, power management, Thin films, optical metrology, high-volume production, wafer-scale packaging, Tool development



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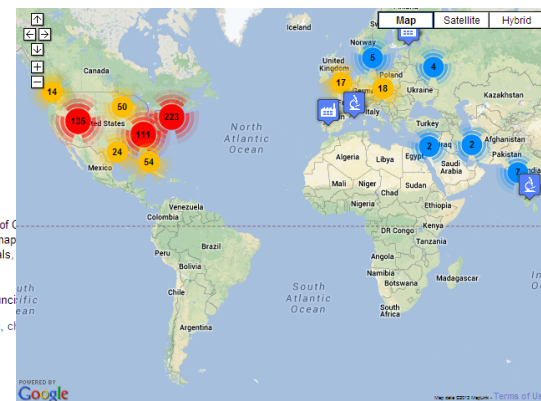
Mehlika Ayla Kiser
Postdoctoral Research Fellow
Department of Chemistry
University of Oregon
kiser2@uoregon.edu
Mailing Address ☐

Mehlika Ayla Kiser is a postdoctoral research fellow in the Department of Chemistry at the University of Oregon, where she is developing a characterization roadmap of nanoparticles, biomimetic syntheses and applications of nanomaterials.

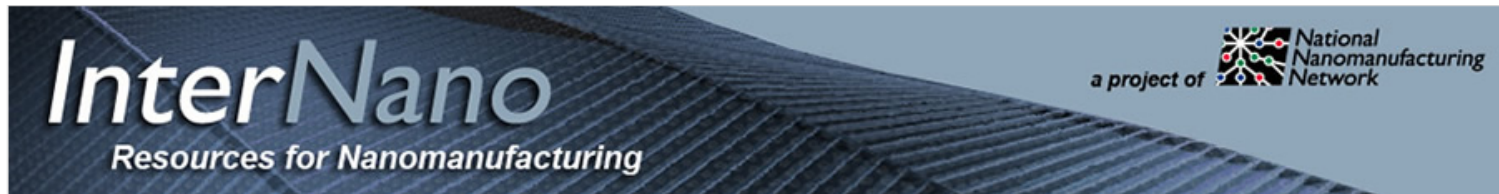
Professional Affiliations

Safer Nanomaterials and Nanomanufacturing Initiative, International Council on Nanotechnology

Tags: Nanoparticles, nanomaterials, Chemical surface functionalization, characterization



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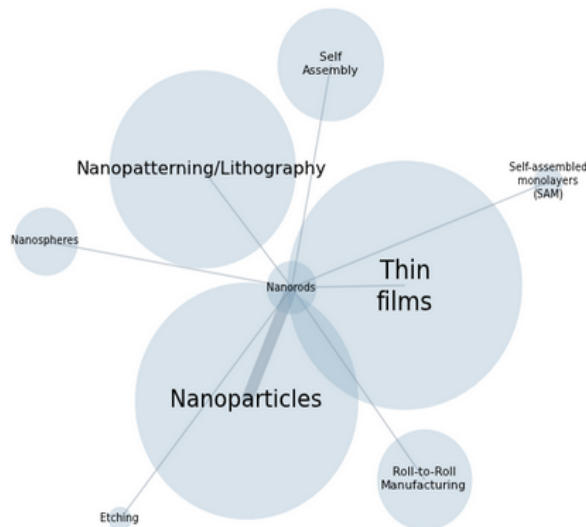


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InterNano

All Resources are linked by the taxonomy



[Home](#) > [Resources](#) > [Taxonomy](#)

Taxonomy

Click on the  to expand each category. Click on the category name to view related content.

- ▶ **Areas of Application**
- ▶ **Environment, Health, and Safety**
- ▶ **Informatics and Standards**
- ▼ **Nanomanufacturing Characterization Techniques**
 - ▶ Charge Transport Characterization
 - ▶ Diffraction and Scattering
 - ▼ **Electrochemical Characterization**
 - Cyclic voltammetry (CV)
 - Electrochemical quartz crystal microbalance (QCM)
 - Impedance spectroscopy (IS)
 - Linear sweep voltammetry (LSV)
 - ▶ Magnetic Characterization
 - ▶ Mechanical Property Characterization
 - ▶ Optical Spectroscopy
 - ▶ Other Characterization Techniques
 - ▶ Scanning Electron Microscopy (SEM)
 - ▶ Scanning Probe Microscopy
 - ▶ Thermal Analysis
 - ▶ Transmission Electron Microscopy (TEM)
- ▶ **Nanomanufacturing Processes**
- ▶ **Nanoscale Objects and Nanostructured Materials**
- ▶ **Social and Economic Impacts**
- ▶ **Tool development**

Comments

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Special Initiatives: Standards - ISO TC 229 Project

ISO 80004-9: "Terminology and Definitions for Nanomanufacturing Processes"

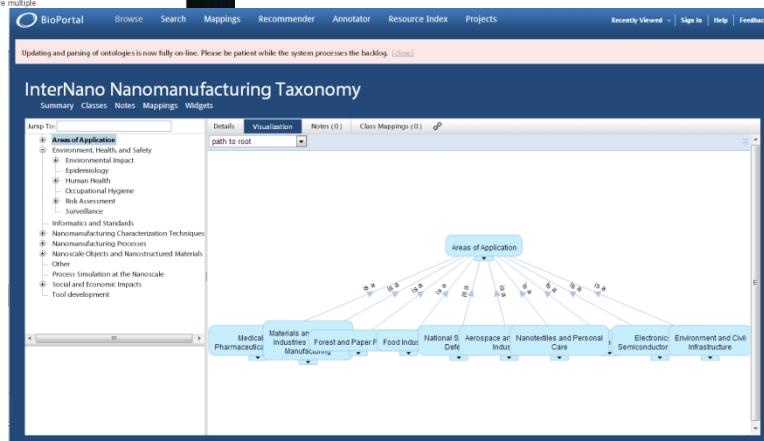
- Based on **InterNano** nanomanufacturing process taxonomy and BSI nanofabrication PAS 135
- Creating a master taxonomy in nanomanufacturing
- Framework accommodates new process terms
- Feeds back into InterNano
- Industry, government and academic participation

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)

ISO: Nanomanufacturing Processes: Major Sections

Taxonomy

- General Terms
- Assembly Techniques
- Biological Techniques
- Nanostructured Materials Synthesis Methods
- Deposition Methods
- Etching Methods
- Nanocomposite Manufacturing Methods
- Nanoparticle Synthesis
- Nanopatterning Lithography
- Roll-to-roll Manufacturing Techniques
- Self-Assembly and Directed Self-Assembly



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InterNano Provides CONTEXT for the “Informatics for Nanomanufacturing” area

- The NNN mission is to understand the WHAT and the WHY in Nanomanufacturing
 - i.e., what materials, what manufacturing processes, what hardware and software tools, what data are needed for application development, manufacturing, and commercialization.
- InterNano has a taxonomy pertinent to manufacturing nanoinformatics, including terminology of more than 100 nanomanufacturing processes from the published ISO TC229 standard on Nanomanufacturing Processes.

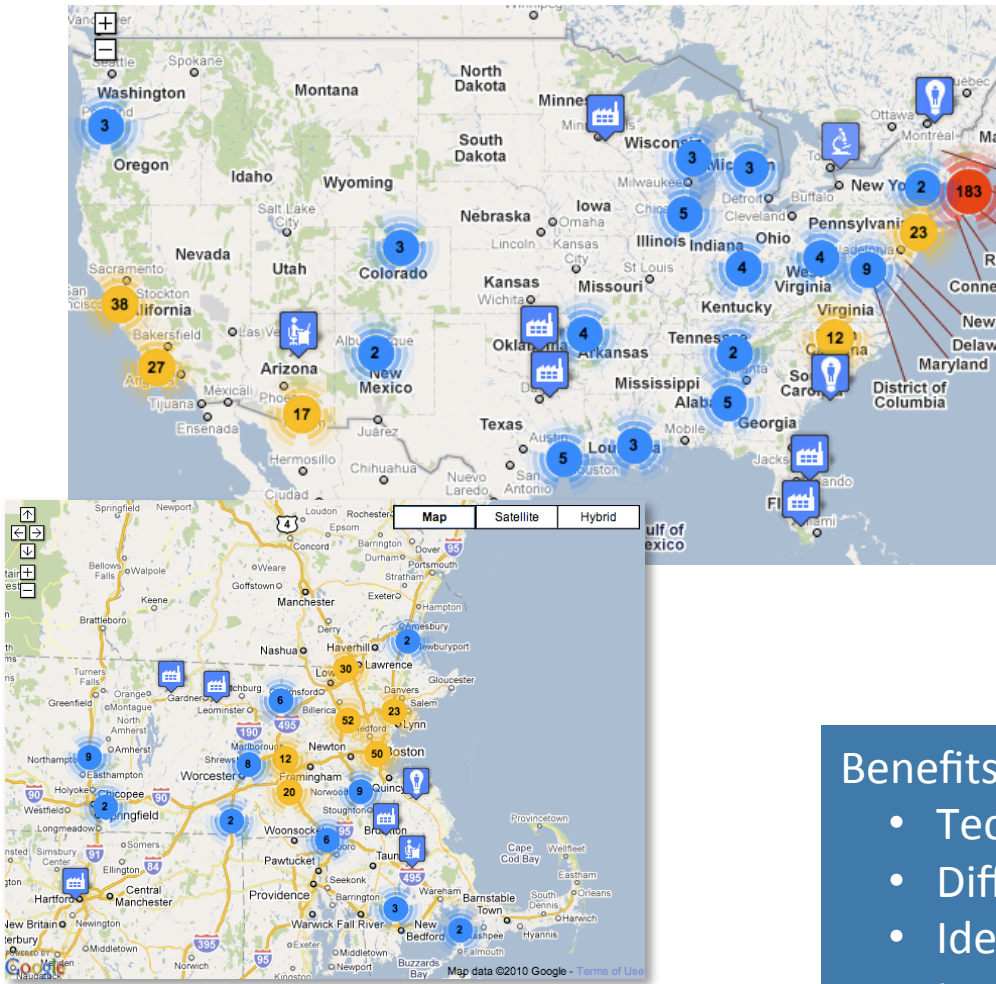
InterNano -Opportunities

Informatics

- Process Database development and tools
 - More articulation of database coupled with process modeling tools
- Expand and interface with NanoMaterials Registry, nanoHub, and others
 - Validate models, share data, develop NM explicit tools.
- Provide access to data and software tools to help design and implement nanomanufacturing processes efficiently.

Future NNN Focus and Industry Outreach

Economic Analysis



Database Assessment Tools for:

- Industry sector trends
- Supply chain analysis
- Workforce, Best Practices

Technical Approaches

- Data Mining/Analysis
- Business/Industry Analytics

Measured Outcomes:

- Economic Impact
- Forecasting
- Strategic Partnering

Benefits

- Technology matching
- Diffusion index of nanotech
- Identification of business & technology challenges