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

Jessica Adamick - Project Manager of InterNano (2011-2013)

Robert Stevens – Web Development

National Nanomanufacturing Network

InterNano

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.

National Nanomanufacturing Network

InterNano
Resources for Nanomanufacturing

CHM
Center for Hierarchical Manufacturing

www.umass.edu/chm

www.r2rnano.org

www.internano.org

National Nanomanufacturing Network

InterNano

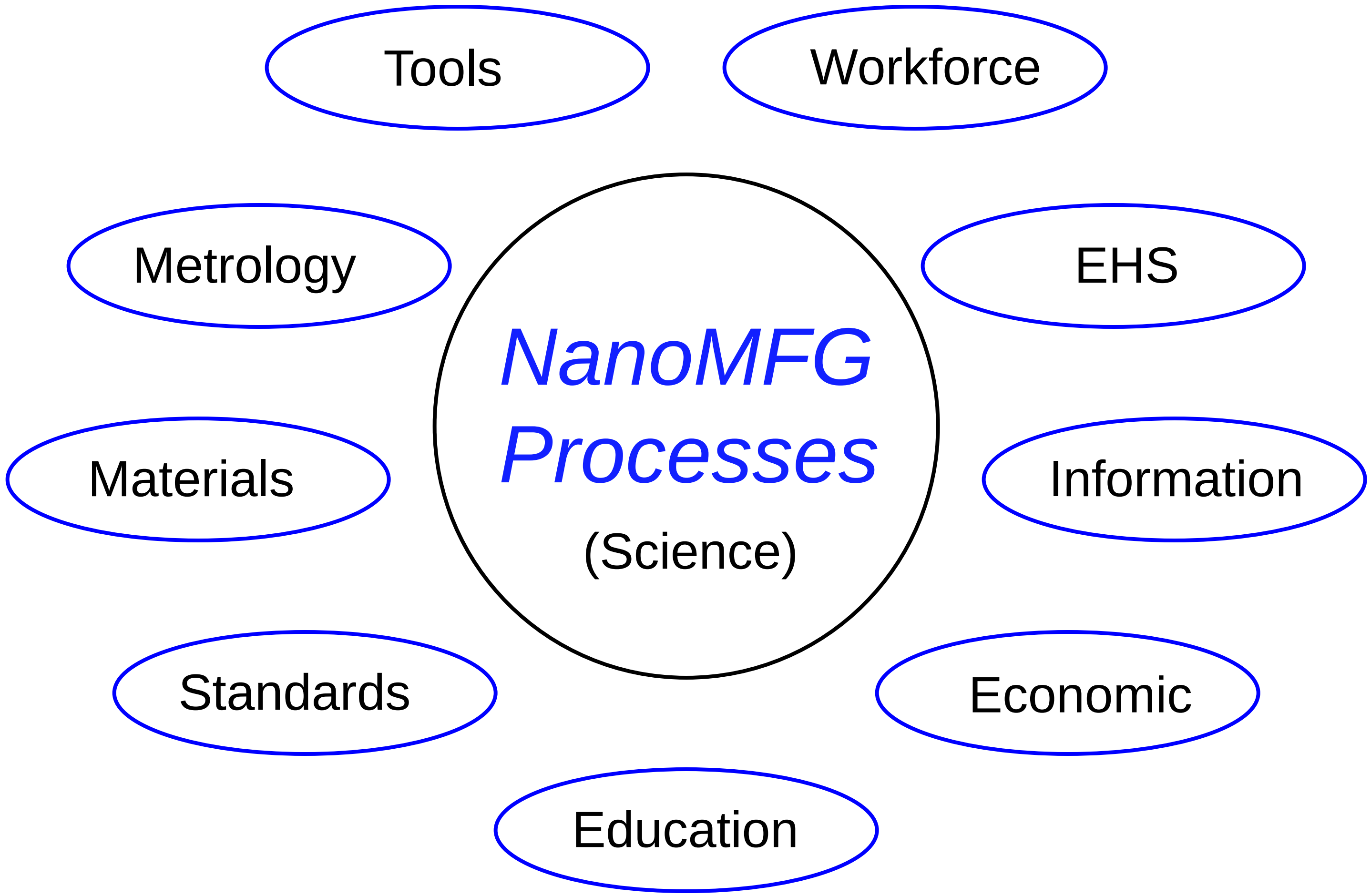
NNN: Key Partners and Affiliates

- **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

National Nanomanufacturing Network

InterNano

Needed Nanomanufacturing Infrastructure: Physical and Intellectual



Information • Tools • Know-how • Roadmaps

National Nanomanufacturing Network

InterNano

NNN Outreach Activities: Areas for Growth

- **Special Initiatives Supporting Nanomanufacturing Infrastructure**
  - Ongoing coordination and outreach to nanomanufacturing community:
    - Lead ISO TC 229 standards project on "Terminology and Definitions for Nanomanufacturing Processes"
    - Major contributor to activities on a U.S. nanoinformatics roadmap
    - Briefings to NILI Working Group (2/21/12), DoD-JDMTP (3/29/12)
    - Board of Advisors – NanoBusiness & Commercialization Association (NanoBCA)
- **NNN Workshops and Conferences**
  - Nanomanufacturing Summit 2012 (September 2012, Boston, MA)
  - Workshop on Nanofabrication Technologies for Roll-to-Roll Processing (September 2011, Boston, MA)
  - Nanoinformatics 2012 (December 2011, Arlington, VA, July 2012, Portland, OR)
- **Community Outreach**
  - Participant monthly NanoBCA telecon with NNCO
  - Weekly mailer and monthly newsletter
  - Co-organized NM Summit 2011 with NanoBCA, will co-organize NM Summit 2012
- **InterNano: the online information service of the NNN**

National Nanomanufacturing Network

InterNano

National Nanomanufacturing Network

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)

National Nanomanufacturing Network

InterNano

InterNano

Resources for Nanomanufacturing

a project of National Nanomanufacturing Network

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

www.internano.org

National Nanomanufacturing Network

InterNano

Process Database

InterNano
Resources for Nanomanufacturing
a project of National Nanomanufacturing Network

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:

1. Lithographic patterning of wafer-scale traces of Al_2O_3 (10 nm thick) followed by 0.5 nm of Fe catalyst.
2. Growth is … in which the height and diam… n exposure time.
3. This is fol… s the chemical bond between … ed by the weaker van der Waals…
4. Transfer i… ch the transfer substrate … ing the patterned arrays.

(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 × 5 mm wide diamond window.

Notes: A key … e as-grown nanotubes during the vapor etch process, thereby eliminating … wing reuse of the original patterned catalyst template.

Equipment R…

- Chemica…

References:

- Pint CL, … 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.

UMLinks

This work is licensed under a Creative Commons Attribution-NonCommercial 3.0 Unported.

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

DOI: 10.4053/pr066-130307

XML

Views: 231

What is the Process Database?

The InterNano Process Database is a knowledge base of techniques for processing nanoscale materials, devices, and structures that includes step-by-step descriptions, images, notes on methodology and environmental variables, and associated references and patent information.

The purpose of the Process Database is to facilitate the sharing of appropriate process knowledge across laboratories.The processes included here have been previously published or patented.

Adding a Process

If you have a published and/or patented process that you would like to include in the InterNano Process Database, you can either contact us and we will add the process for you, or you can register on InterNano and add the process yourself using our easy upload form.

We do include the option of applying Creative Commons licenses to processes, *for those that have not been previously published*, so that contributors can be appropriately attributed.

Questions?

Send us your feedback or contact us directly if you need more help with the Process Database.

NNN Newsletter

National Nanomanufacturing Network
Newsletter
InterNano

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

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

Library | Directory

Process Database | Calendar

Expert Reviews

Directory

InterNano
Resources for Nanomanufacturing
a project of National Nanomanufacturing Network

Search

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

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.

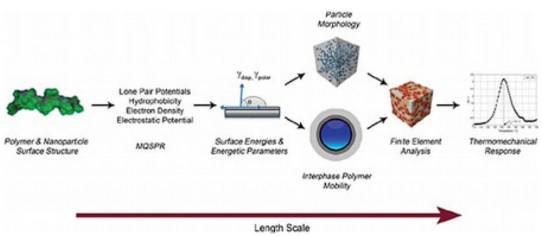


Figure 1. A schematic showing the genomics approach to predicting the thermomechanical response. From left to right shows: MQSPR is used to relate the polymer and nanoparticle surface structure to the polar and dispersive components of the polymer and nanoparticle surface energy. The surface energies 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 using 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/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

Most Recent | Related | Most Read

- Paving the Way for Real-World Nanotechnology Products
- Trade Barriers that U.S. Small and Medium Enterprises Perceive as Affecting Exports to the European Union
- Assessing the Assessment of the Economic Impact of Nanotechnology
- Virtual Design Methods Provide Strategy for Innovation through Nanomaterial Database Development
- UC Center Receives $24 Million to Transform How Nanomaterials are Tested for Safety

Browse by Subject | RSL Initiatives in Nanotechnology | Directory

Resources for Nanomanufacturing

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

Home ▸ Resources ▸ Directory ▸ Organization

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 discretes 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

Home ▸ Resources ▸ Directory ▸ Expert

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

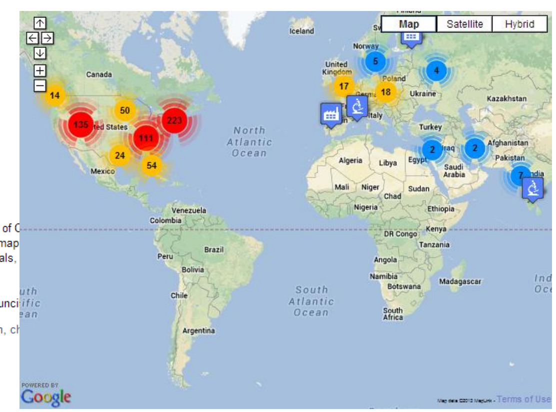
Mailing Address ⊞

Mehlika Ayla Kiser is a postdoctoral research fellow in the Department of C
hydrophobicity of nanoparticles and developing a characterization roadmap
of nanoparticles, biomimetic syntheses and applications of nanomaterials,

Professional Affiliations

Safer Nanomaterials and Nanomanufacturing Initiative, International Counci

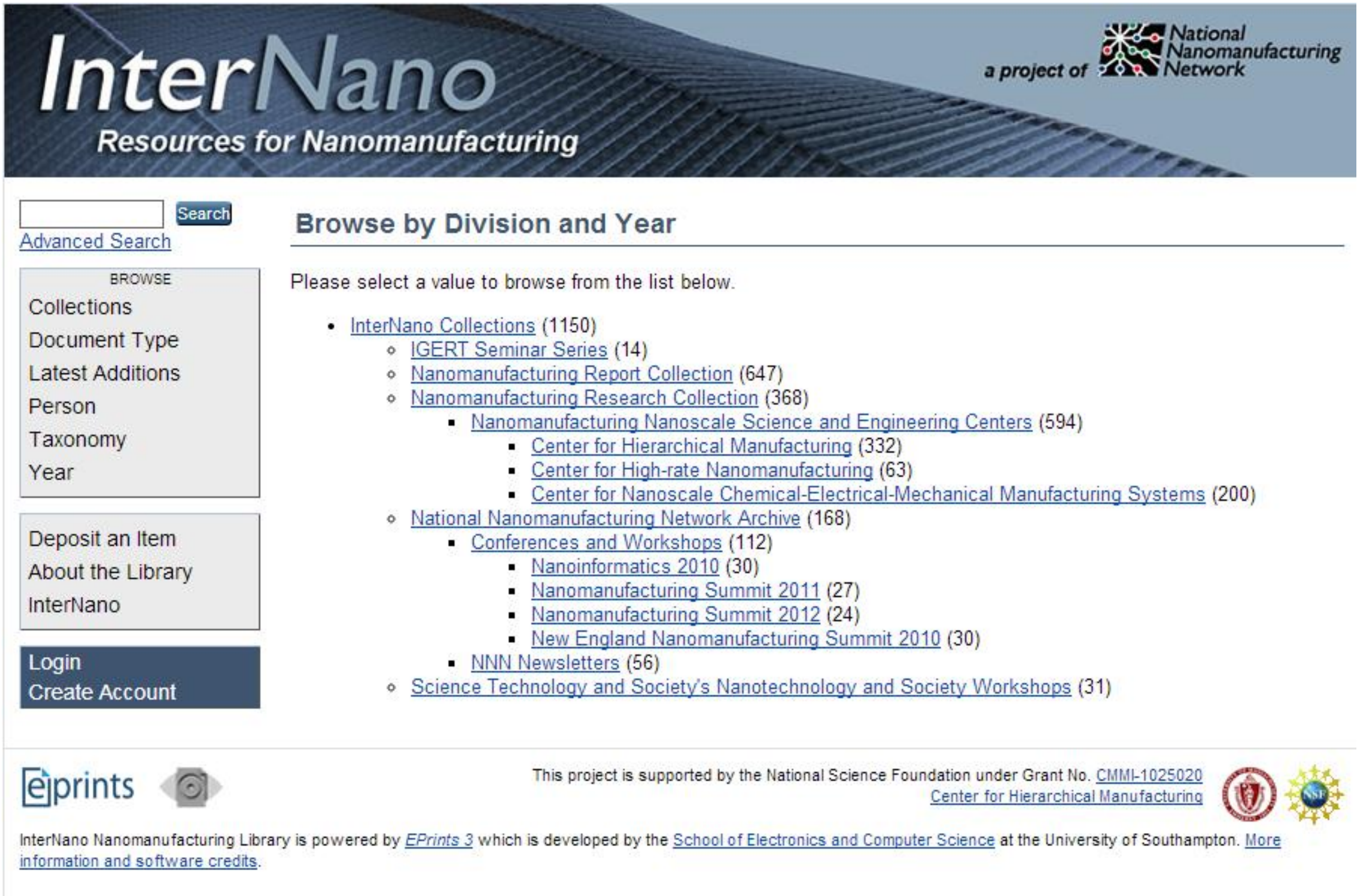
Tags: Nanoparticles, nanomaterials, Chemical surface functionalization, ch



National Nanomanufacturing Network

InterNano

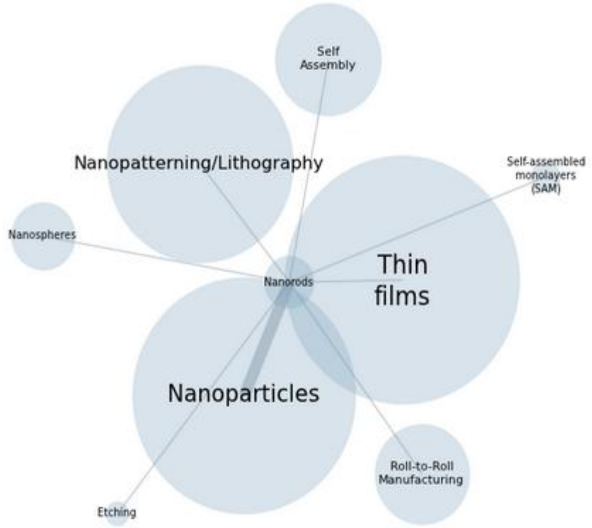
Research Library



National Nanomanufacturing Network

InterNano

All Resources are linked by the taxonomy



National Nanomanufacturing Network

InterNano

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

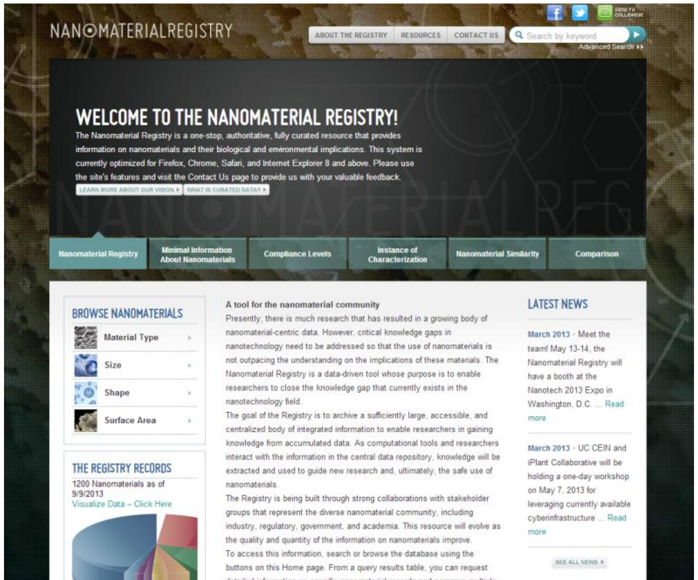
Argentina, Belgium, Canada, China, Finland, Germany, Iran, Italy, Japan, Korea, Malaysia, Mexico, Netherlands, Portugal, Romania, Russia, Singapore, South Africa, Spain, Switzerland, Thailand, USA (co-lead), UK (co-lead)

National Nanomanufacturing Network

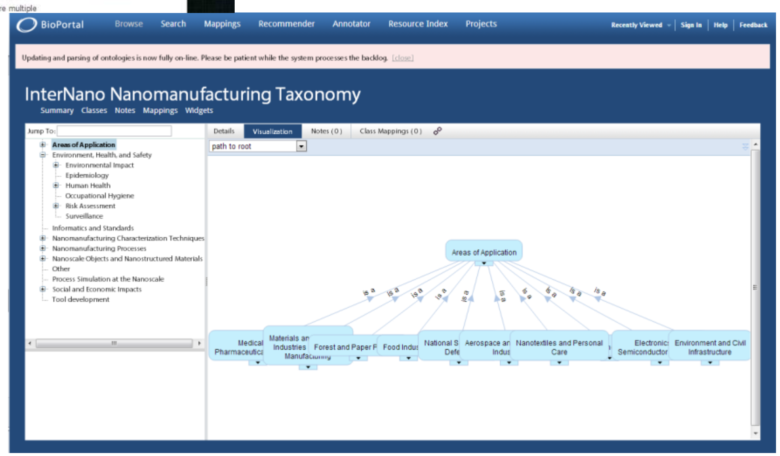
InterNano

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



National Nanomanufacturing Network

InterNano

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 soon-to-be-published ISO TC229 standard on Nanomanufacturing Processes.

National Nanomanufacturing Network

InterNano

InterNano 2013-2016

- **Strategic Planning for National Nanomanufacturing Roadmap**
  - Focused Workshops and Events
  - Economic Analysis
  - Supply Chain, Workforce Assessments
  - Regional, Local, National trends and models

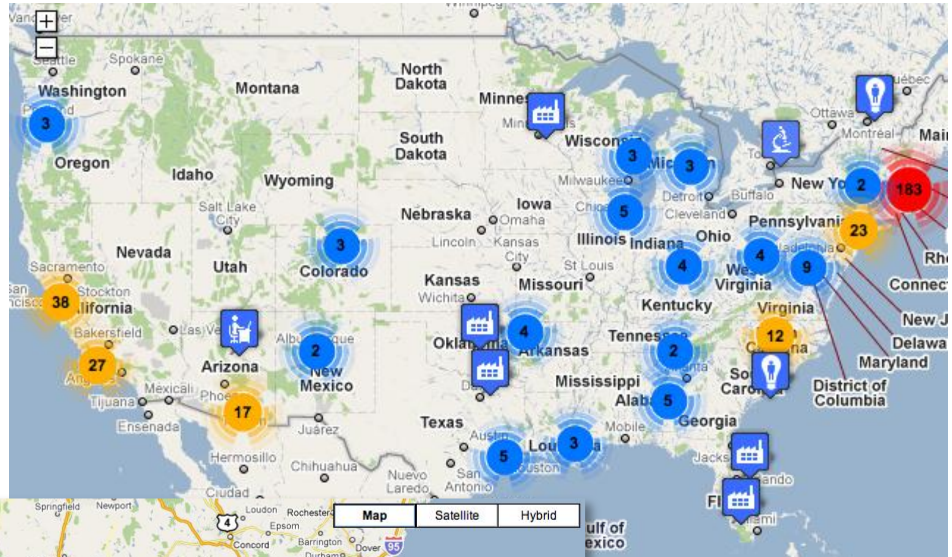
- **Informatics**
  - Process Database development and tools
  - Expand and interface with NanoMaterials Registry, nanoHub, and others
  - Provide data and software tools to help design and implement nanomanufacturing processes efficiently.

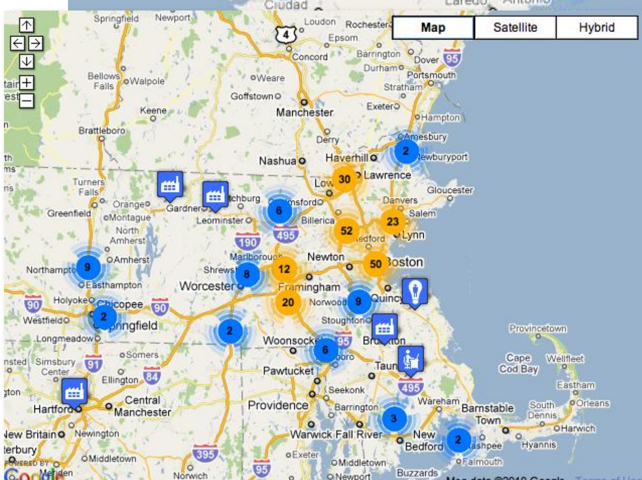
National Nanomanufacturing Network

InterNano

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

National Nanomanufacturing Network

Kwong Chan, Isenberg School of Management

InterNano