

Supporting Manufacturing to Promote U.S. Innovation and Industrial Competitiveness

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NIST

**National Institute of
Standards and Technology**
U.S. Department of Commerce

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NIST Manufacturing Portfolio



The Future - Advanced Manufacturing

Advanced manufacturing is . . .

. . . a family of activities that (a) depend on the use and coordination of information, automation, computation, software, sensing, and networking, and/or (b) make use of cutting-edge materials and emerging capabilities enabled by the physical and biological sciences, for example nanotechnology, chemistry, and biology. This involves both new ways to manufacture existing products, and especially the manufacture of new products emerging from new advanced technologies.

President's Council of Advisors on Science and Technology (PCAST) Report, June 2011

This requires:

- ✓ Innovative Approaches
- ✓ Multidiscipline Expertise
- ✓ Technology Adoption
- ✓ Partnerships and Collaboration

Federal Manufacturing Initiatives

- National Institute of Standards and Technology – NIST <http://www.nist.gov/>
 - Advanced Manufacturing Research <http://www.nist.gov/manufacturing-portal.cfm>
 - Manufacturing Extension Partnership – MEP <http://www.nist.gov/mep/>
 - Advanced Manufacturing Technology – AMTech <http://www.nist.gov/amo/index.cfm>
- National Network for Manufacturing Innovation – NNMI <http://www.manufacturing.gov/welcome.html>
- Investing in Manufacturing Communities Program – IMCP <http://www.eda.gov/challenges/imcp/>
- Maker Education Initiative <http://www.whitehouse.gov/administration/eop/ostp/initiatives>
- Jobs and Innovation Accelerator Challenge <http://www.eda.gov/challenges/jobsaccelerator/>

U.S. Innovation Agenda – NIST has an increasing role



President Obama
State of the Union Address
February 13, 2013

Our first priority is making America a magnet for new jobs and manufacturing.

Last year, we created our first manufacturing innovation institute in Youngstown, Ohio. A once-shuttered warehouse is now a state-of-the-art lab where new workers are mastering the 3D printing that has the potential to revolutionize the way we make almost everything. There's no reason this can't happen in other towns.

So tonight, I'm announcing the launch of three more of these manufacturing hubs, where businesses will partner with the Departments of Defense and Energy to turn regions left behind by globalization into global centers of high-tech jobs.

And I ask this Congress to help create a network of 15 of these hubs and guarantee that the next revolution in manufacturing is made right here in America.

NIST Activities in Advanced Manufacturing

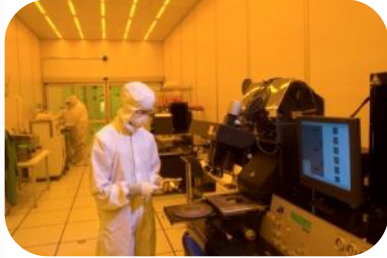
- **NIST Labs**
 - Precision Measurements
 - Bio- and Nano-manufacturing
 - Smart Manufacturing
 - Advanced Materials
- **Advanced Manufacturing Program Office**
 - NNMI
 - AMTech
- **Manufacturing Extension Partnership**
 - National Network of MEP Centers
 - M-TAC

New Lab Initiative Funding:

- FY2012 – \$19M
- FY2013 – \$15M
- FY2014 – \$30M

We (NIST) want to make sure that our programs are focused on what we “**Should Do**” rather than what we “**Could Do**” to strengthen U.S. manufacturing, new materials discovery and innovation.

NIST Programs



NIST Laboratories

- Provide measurement and standards solutions for industry and the nation

Manufacturing Extension Partnership - MEP

- Nationwide network of centers helps smaller manufacturers compete globally

Advanced Manufacturing Office - AMO

- Enhances technology transfer in U.S. manufacturing industries and helps companies overcome technical obstacles to scaling up production of new technologies

Baldrige Performance Excellence Program

- Strengthens performance excellence in U.S. organizations



NIST's Programs That Support Manufacturing

- **Basic Research** – NIST Laboratories
 - **User Facilities** – CNST & NCNR
-
- **Centers of Excellence** – Cybersecurity & Advanced Materials
 - **Consortium Building** – AMTech
 - **Partnerships for Technology Development** – NNMI
 - **Regional Partnerships for Technology Adoption** – MEP
-

This provides multiple resources and connection points to identify, develop and adopt innovative technology.

<http://www.nist.gov>

NIST Programs That Support Manufacturing

NIST Laboratories

Measurement Science

Standards Development

Calibration Services

AMTech

Consortia Formation
and Technology Roadmaps

NNMI

Applied Research, Development,
& Demonstration; Scale-Up

MEP

Technology Deployment and
Adoption

Research

Commercialization

NIST Core Competency – Measurement Science

Measurement is key to technological innovation

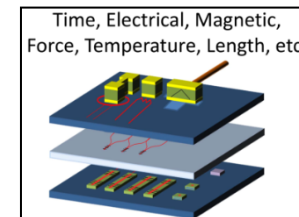
- ✓ Understand how things work
- ✓ Improve the design
- ✓ Optimize control
- ✓ Validate & certify

Key to development of **standards** – repeatability & quality

Advanced Manufacturing: *NIST-on-a-Chip*

An integrated program to develop and deploy SI-traceable measurements and physical standards that are:

- **Deployed** in the customer's factory floor, lab, device, system, home, anywhere...
- **Usable** - Usually small size (important exceptions), low power consumption, rugged, easily integrated and operated.
- **Flexible**
 - Provide a broad range of SI-traceable measurements and standards (often quantum-based) relevant to the particular customer needs / applications.
 - One, few, or many measurements from a single small form package.
- **Manufacturable** - Potential for production costs commensurate with the applications.
 - Low cost for broad deployment; or
 - Acceptable cost for high-value applications.



NIST is building on its earlier successes to: develop much broader range of deployable SI-traceable measurements and integrate multiple measurements into single devices.

- **Photonic sensing of thermodynamic quantities**
Replace obsolete, limited performance resistance thermometers with easily deployable, robust photonic systems (fiber systems with chip-based sensors).
- **Quantum-based electrical standards**
Expand capabilities of existing chip-based voltage measurements and prepare for new measurement technologies for current and other electrical quantities.
- **Atom-based measurements in vapor cells**
Dramatic improvement in deployed measurements of time, length, magnetic field and other quantities.
- **Optical / photonic input and output**
Microscale laser frequency comb technologies to transduce "on chip" measurement to user-friendly quantities and sensed parameters to "chip measurable" quantities.

Advanced Manufacturing: *Measurement Science and Standards to Support Emerging Technologies in Bio- and Nano-manufacturing*

This program supports manufacturers in overcoming barriers to the high volume production of transformative materials and products based on emerging trends in nanotechnology and biotechnology

Barriers exist for full commercial exploitation of manufacturing processes integrating emerging technologies

- Lack of nanomanufacturing and nanomaterial characterization tools means significant delay and high cost of product development
- Lack of measurements to characterize the environmental, health, and safety risks of engineered nanomaterials
- Biotechnology medicines are the fastest growing category of health care spending, but manufacturing processes are not optimized

NIST will:

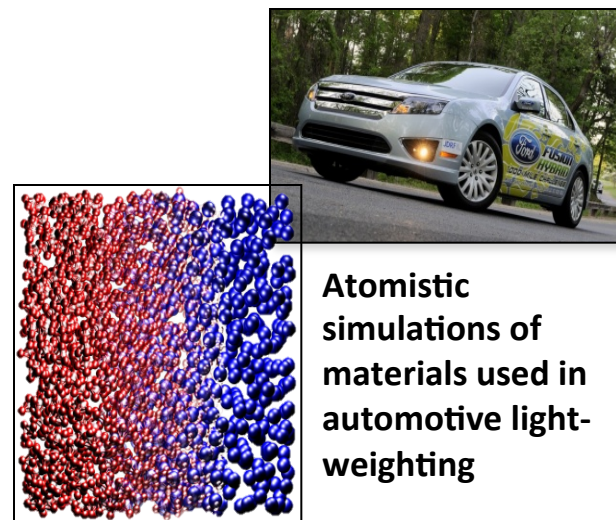
- Characterize manufactured nanomaterials to enable accurate assessment of health and environmental risks
- Develop innovative measurement methods to ensure product quality during high-speed processing of nanocomposite systems
- Better tools to determine safety and efficacy of biopharmaceuticals including characterization of 3-D protein structure and glycosylation
- Support new manufacturing paradigms that use cells as factories



Advanced Manufacturing: Measurement Science and Data Infrastructure for Advanced Materials

This program is focused on enabling and accelerating the creation and manufacture of innovative, advanced materials via the integration of modeling and simulation, experimental tools, and digital data/informatics.

- In the same way that silicon in the 70s led to the modern IT era, advanced materials could fuel multibillion dollar industries in energy, national security, and human welfare.
- This effort will provide critical links needed to realize the vision of the *Materials Genome Initiative (MGI)*, aimed at accelerating industrial innovation by significantly reducing the timeline from discovery to commercial deployment for new materials.
- NIST will support the MGI and enable advanced materials by developing:
 - Computational and validated databases, data assessment tools, and standards
 - Modeling and simulation tools
 - Mechanisms for exchange of information



Atomistic simulations of materials used in automotive light-weighting

Advanced Manufacturing: *Smart Manufacturing*

NIST work in this area will provide U.S. manufacturers with foundations for optimizing production and quality.

Smart Manufacturing refers to production systems at the equipment, factory, and enterprise levels that integrate cyber and physical systems to enable innovative production, products, and systems of products. This requires infrastructural advances to enable:

- smart operations systems to monitor, control, and optimize performance
- systems engineering-based open architectures and standards, and
- embedded and/or distributed sensing, computing, communications, actuation, and control technologies

NIST will:

- Develop measurements and standards for a **quality measurement system** focusing on automated in-process quality monitoring and control
- Develop a testbed which integrates a systems architecture framework and an open standards platform for **facilitating the simultaneous engineering of the computational (cyber) and physical elements of manufacturing systems**



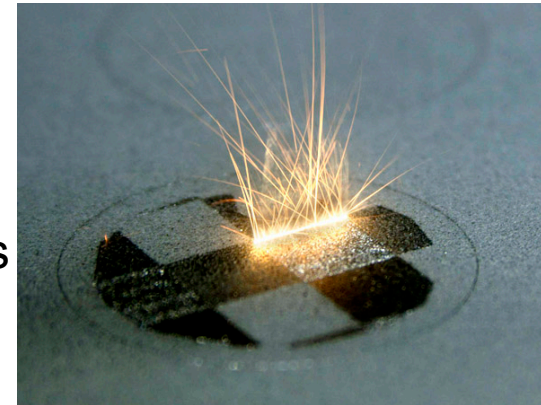
Measurement Science for Additive Manufacturing

Program Description:

<http://www.nist.gov/el/isd/sbm/msam.cfm>

Four focus areas:

1. Characterization of Additive Manufacturing Materials
<http://www.nist.gov/el/isd/sbm/camm.cfm>
2. Real-Time Control of Additive Manufacturing Processes
<http://www.nist.gov/el/isd/sbm/rtcamm.cfm>
3. Qualification of Additive Manufacturing Materials, Processes, & Parts
<http://www.nist.gov/el/isd/sbm/qammpp.cfm>
4. Additive Manufacturing Systems Integration
<http://www.nist.gov/el/msid/lifecycle/sifam.cfm>



High impact partnerships with manufacturers

Electronics Industry -

Partnerships with e.g. SEMATECH, INTEL, IBM and Rohm & Haas enabled:

- industry adoption of models that optimize processes for deposition of metals into nanoscale IC vias and interconnects
- measurements and models for nanoporosity necessary for manufacturers to adopt a new generation of low-K dielectric materials
- X-ray based dimensional metrology instrumentation needed to quantify the shape, fidelity and roughness of 3D chip nanostructures



MOTOROLA



Automotive Industry -

Partnerships with USCAR, USX, Alcoa, GM and Ford enabled:

- Development of instrumented dies needed to quantify the sheet-forming behavior of emerging lightweight alloys for fuel efficient vehicles
- Industry adoption of new used to accelerate the design of dies suitable for lightweight aluminum and high-strength steel alloys.



The Hollings Manufacturing Extension Partnership

MEP

Manufacturing Extension Partnership - MEP

Federal-State-Industry partnership that provides U.S. manufacturers with access to technologies, resources, and industry experts

- MEP Centers located in all 50 states and Puerto Rico
- Work directly with local manufacturing communities, as a strategic advisor to connect manufacturers to public and private resources essential for competitiveness and profitability

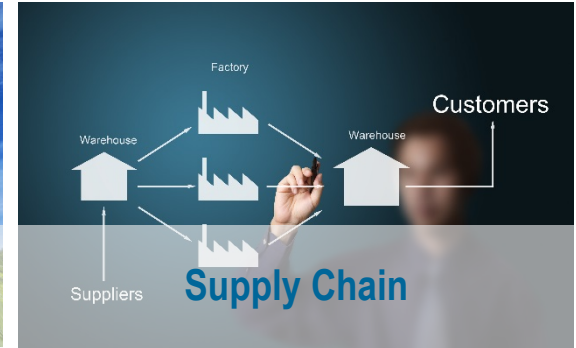
Current MEP efforts:

- Help manufacturers develop innovative practices to leverage resources to couple cost reduction strategies with company growth
- Expand focus to include technology transition services for small and mid-sized U.S. manufacturers
- Continue to partner with other Federal agencies, e.g., in support of sustainable manufacturing practices (E3) and overseas expansion (ExporTech)

<http://www.nist.gov/mep/>



MEP Program Initiatives



MEP's Program Initiatives

are aimed to help manufacturers identify opportunities that will accelerate and strengthen their growth and competitiveness in the global marketplace

Advanced Manufacturing Technology Consortia

AMTech

What is AMTech?

The Advanced Manufacturing Technology Consortia (AMTech) Program

Launched by NIST in FY 2013

- To incentivize the formation of and provide resources to industry-driven consortia
 - To support basic and applied research
 - On long-term, pre-competitive and enabling technology development
- Support for the U.S. manufacturing industry
- \$15M annual program



AMTech-supported consortia will strengthen the capacity of U.S. industry and the nation to compete in global markets

How Will AMTech Work?

- AMTech Planning Awards will fund eligible applicants to create new or strengthen existing driven technology consortia
- AMTech supported consortia will:
 - Identify and prioritize long-term, pre-competitive industrial research needs – technology roadmaps;
 - Enable technology development;
 - Create the infrastructure necessary for more efficient transfer of technology;
 - Represent a broad range of involved firms across stages of the value chain.
- When fully implemented, NIST envisions AMTech to offer funding in two broad areas: *Planning Awards* and *Project Awards*

2013 AMTech Competition Results

www.nist.gov/amo/fundedawards.cfm

- **Nineteen (19) Planning Awards, totaling \$9 million**
 - 82 unique applications received
 - Applicants: 37 Academia / 42 Not-for-Profit / 1 State Gov't / 2 For-Profit

- **Consortia Characteristics**










11 New

8 Existing

10 Academia

9 Not-for-Profit

- **Crosscutting Technologies* (# of efforts):**

Additive Manufacturing (1) 	Advanced Forming & Joining Tech (2) 
Advanced Manufacturing & Testing Equipment (7) 	Advanced Materials Design, Synthesis & Processing (2) 
Advancing Sensing, Measurement & Process Control (1) 	Biomanufacturing & Bioinformatics (1) 
Flexible Electronics Manufacturing (1) 	Sustainable Manufacturing (2) 
Visualization, Informatics & Digital Manufacturing Technologies (2) 	

The 2014 AMTech Funding Opportunity

Grants.gov Funding Opportunity No. [2014-NIST-AMTECH-01](#)

For FY 2014

- Applications (proposals) for Planning Awards only

Funding Level & Instrument

- Total funding available: approx. \$5.6 M
- Award size: approx. \$250 k - \$500 k
- Grant or Cooperative Agreement

Key Dates

- Solicitation released: July 30, 2014
- Complementary webinars: August 7 & 14, 2014
- Required Pre-Application due: September 5, 2014
- Pre-Applicants notified: September 24, 2014 (on or about)
- Full Application due: October 31, 2014
- Award Announcement: Q2, CY2015



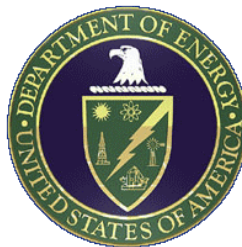
National Network for Manufacturing Innovation

NNMI

Interagency Advanced Manufacturing National Program Office (AMNPO)



Executive Office of the President



Advanced Manufacturing Partnership (AMP/PCAST)

Advanced Manufacturing National Program Office
(housed at DOC - NIST)

National Network for Manufacturing Innovation - NNMI



“Sparking this network of innovation across the country, it will create jobs and will keep America leading in manufacturing...”

President Obama, March 9, 2012

- President asks Congress to authorize initial network of up to 15 Manufacturing Innovation Institutes
- President directs Agencies to work together on Pilot Institute, while designing Institutes with input from Industry and Academia

The “Scale-up” Gap or Missing Middle



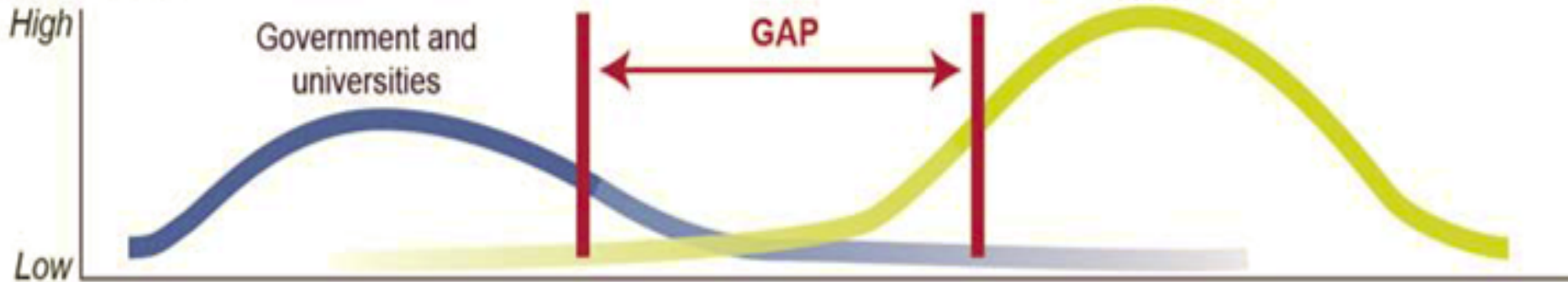
Basic R&D

Common terms
The “valley of death”
The “missing Bell Labs”
The “industrial commons”



Commercialization

Funding/
Investment



Manufacturing-innovation process



Institute Major Activities



Applied Research & Demo projects for

- reducing cost/risk on commercializing new tech.
- Solving pre-competitive industrial problems



Tech Integration - Development of innovative methodologies and practices for supply chain integration



Small/Medium Enterprises

- Engagement with small and medium-sized manufacturing enterprises (SMEs).



Institute



Education, technical skills and Workforce development

Education and training at all levels for workforce development

The Start of a Network...



**Additive
Manufacturing**



**Power
Electronics**



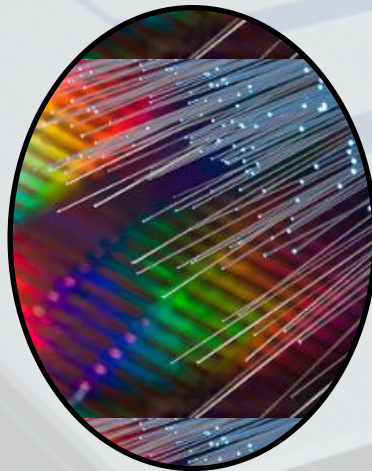
**Digital
Manufacturing**



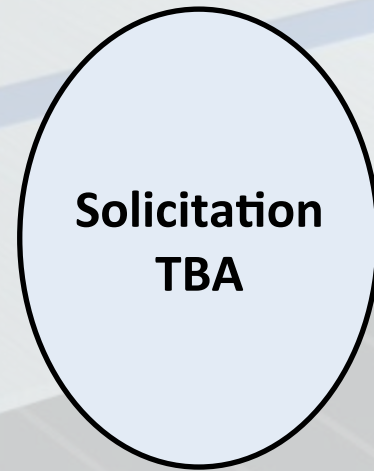
**Lightweight
Metals**



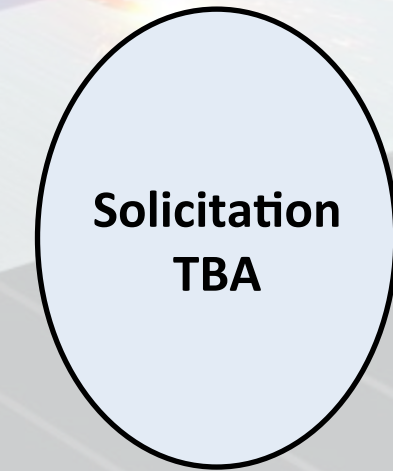
**Adv. Composites
Manufacturing**



**Integrated Photonics
Manufacturing**



**Solicitation
TBA**



**Solicitation
TBA**

Advanced Manufacturing Partnership 2.0

Mission: Encourage approaches that sustain/grow U.S. leadership in Advanced Mfg.

19 Senior Leaders -industry, academia & labor

Steering Committee Co-Chairs

Rafael Reif Andrew Liveris



Massachusetts
Institute of
Technology



GLOBALFOUNDRIES



South Central College
A MINNESOTA COMMUNITY AND TECHNICAL COLLEGE



Honeywell



Harper College

NORTHROP GRUMMAN



SIEMENS



AMP Coordinating Group
DOW, MIT, WH, AMNPO

AMP 1.0 – 16 Recommendations

Pillar I: Enabling Innovation

Pillar II: Securing the Talent Pipeline

Pillar III: Improving Business Climate

AMP 2.0 focused on Implementation kickoff Sept 30, 2013

- Regional engagement and outreach
- Implementation on national initiatives
- Five active Working Teams to issue “letter-reports”

AMP 2.0 Working Teams

1. Transformative manufacturing technologies
2. Demand-driven workforce solutions
3. Supporting implementation of NNMI
4. Technology scale-up policy
5. Improving the Manufacturing image

Final AMP 2.0 report released Monday, October 27, 2014
http://sites.nationalacademies.org/PGA/step/PGA_152473.

Questions?