Overview of NIST Activities in Support of Advanced Manufacturing

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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 Nanomanufacturing
  - Smart Manufacturing
  - Advanced Materials
  - Advanced Neutron Measurements
- National Advanced Manufacturing Program Office
  - AMTech
  - NNMI
- Manufacturing Extension Partnership
  - MTAC

$ +37 M
increase in intramural base funding for Advanced Manufacturing and Materials research programs over past two years

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."

President's FY 2014 Budget Request for NIST Continues Support for Advanced Manufacturing

- **Advanced Manufacturing and Materials (+$50M)**
  - Measurement science and data infrastructure for advanced materials (Materials Genome Initiative) (+$10M)
  - Supporting manufacturing with emerging technologies (+$20M)
  - Precision measurements for manufacturers (+10M)
  - Measurement science to enable the integration and use of smart manufacturing (+$10M)
- **Cybersecurity**
- **Advanced Communications**
- **Cyber-Physical Systems**
- **Disaster Resilience**
- **Forensic Science**
- **Strengthening Technology Transfer**

Credit: Tomlin/NIST

NIST Chief Manufacturing Officer

Roger Kilmer has been reassigned from Director of the Manufacturing Extension Program to the position of NIST Chief Manufacturing Officer.

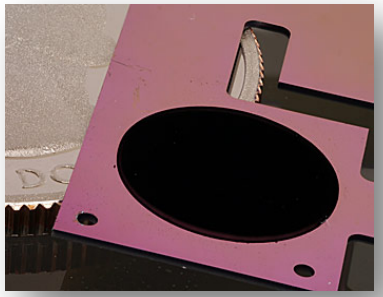
In this capacity, drawing upon his 40 years of experience at NIST, he will provide:

- cross-organizational coordination within NIST's manufacturing programs
- strategic advice to the NIST Director and ADLP on planning, operations and execution of laboratory programs that support manufacturing

It is important for NIST to have a process in place that carefully considers industry needs and inputs when selecting and planning the projects to pursue. NIST interaction with industry is strong, and with further expansion and enhancement, it could provide even more mutual benefits and alignment … **Recent NRC Review of Manufacturing-related Programs at NIST**

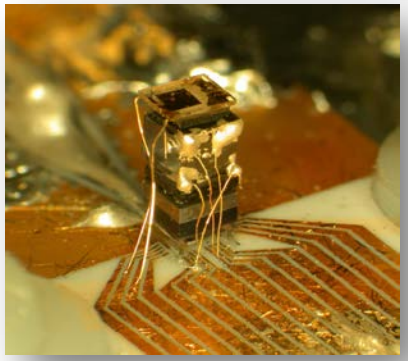
Advanced Manufacturing:
Precision Measurements for Manufacturers

This program supports a new paradigm in self-calibration capabilities for U.S. manufacturers


Credit: Tomlin/NIST

New self-calibrating measurements are important:

- Current methods for calibrating machinery and assessing quality can introduce cost and time delays
- Applies to virtually all manufacturing processes
- New precision measurement capabilities would provide competitive advantage to U.S. manufacturers

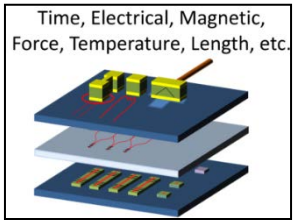

Credit: NIST

NIST will:

- Leverage initial successes, i.e., miniature atomic clocks, into a range of measurements (electrical quantities, pressure, temperature)
- Provide on-chip reference measurements to improve the quality and reliability of manufacturing processes

“Embedded Standards / 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.
- Integrate multiple measurements into single devices.

FY13 activities include:

- **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 Nanomanufacturing*

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: *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

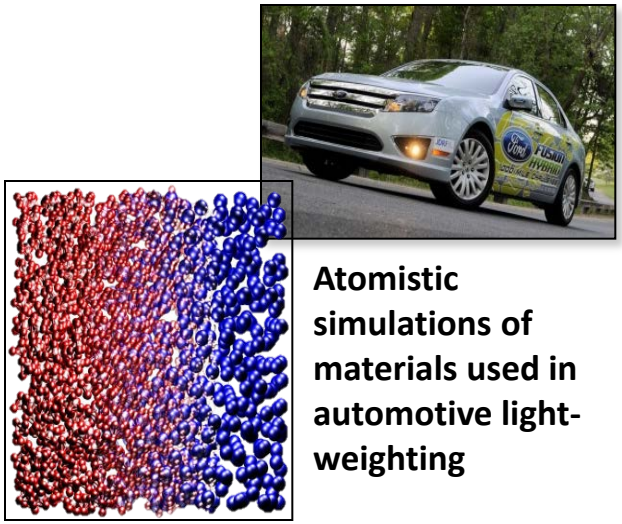
NIST will:

- 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**

Advanced Manufacturing: *Measurement Science and Data Infrastructure for Advanced Materials*

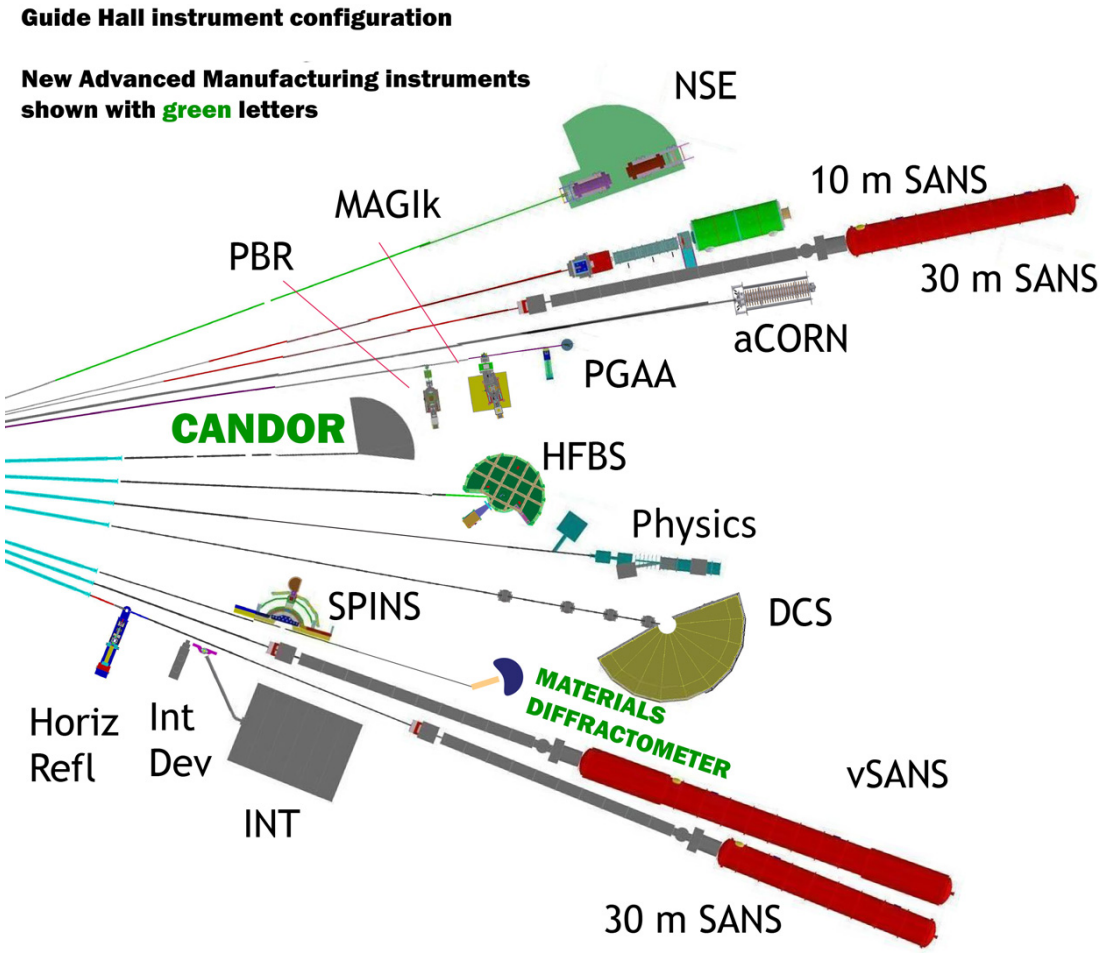
This program is focused on enabling and accelerating the creation and manufacture of innovative, advanced materials via the integration of modeling and simulation, experimental tools, and digital data/informatics.

- 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

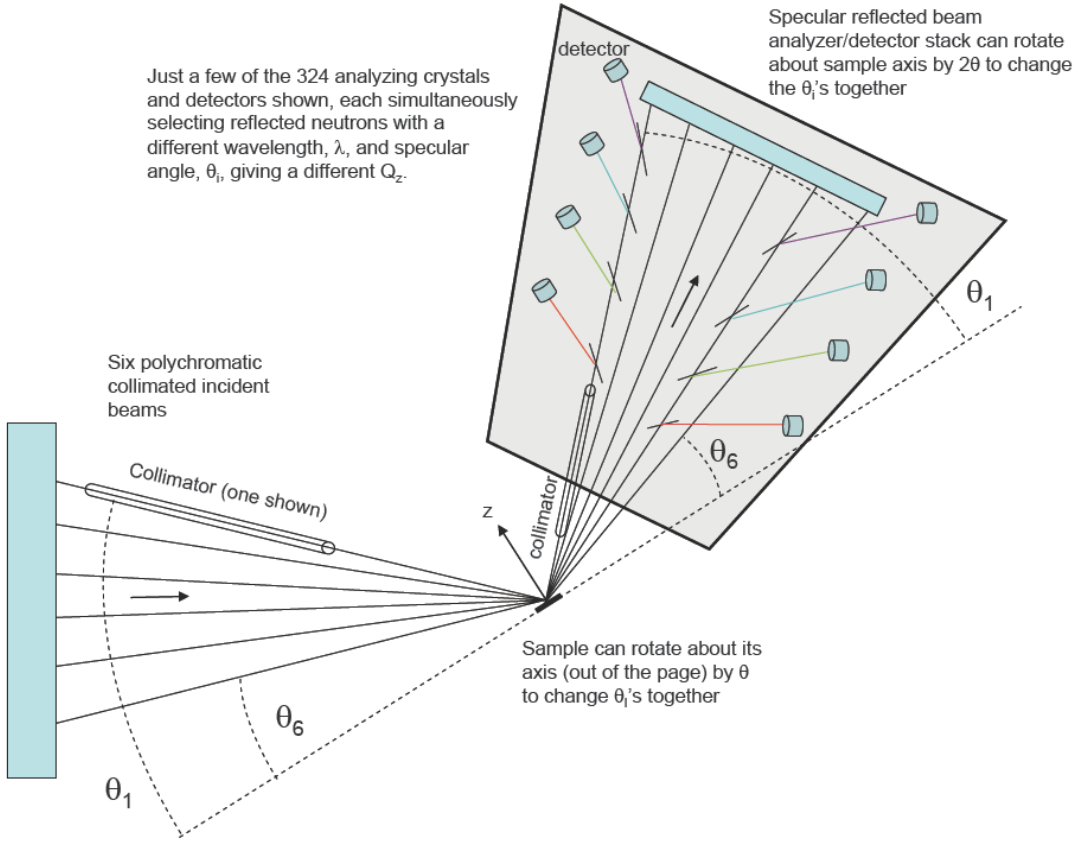
Expanding NIST's Impact in Advanced Manufacturing with Neutron Measurements



Expanding NIST's Impact in Advanced Manufacturing with Neutron Measurements

CANDOR

Chromatic Analysis Neutron Diffractometer Or Reflectometer



Optimized for the kinetics of molecular processes on surfaces and at interfaces

Applications

Soft materials manufacturing

Surface adhesion of bio-pharmaceuticals

Interactions between proteins and bio-membranes

Expanding NIST's Impact in Advanced Manufacturing with Neutron Measurements

Future Plans:

- Develop Strain Mapping Diffractometer
- Develop Materials Diffractometer
- Upgrade Residual Stress Diffractometer
- Upgrade uSANS
- Upgrade High resolution powder diffractometer

We'll continue our discussions with:

- **Update on NIST Extramural Programs in Advanced Manufacturing**
  Frank Gayle, Deputy Director, Advanced Manufacturing National Program Office
  Alex Folk, Program Development Office Director, Manufacturing Extension Partnership

- **A Model for Working with Manufacturers – NIST Center for Automotive Lightweighting (NCAL)**
  Tim Foecke, Director, NCAL and Leader, Materials Performance Group, Materials Science and Engineering Division, Material Measurement Laboratory

- **Lab Tour of the NCAL**
  Tim Foecke, Director, NCAL and Leader, Materials Performance Group, Materials Science and Engineering Division, Material Measurement Laboratory