Introduction to NIST and its role in “Promoting U.S. Innovation and Industrial Competitiveness”

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Major Programs
- NIST Laboratories
- Baldrige Performance Excellence Program
- Hollings Manufacturing Extension Partnership

Major Assets
- ~3,000 employees/~1500 scientists & engineers
- ~2,800 associates and facilities users
- ~1,600 field staff in partner organizations
- ~400 NIST staff on ~1,000 national and international standards committees

NIST-at-a-Glance

NIST has two main campuses......

Gaithersburg, MD
55 buildings; 578 acres

Boulder, CO
26 buildings; 208 acres

+ sites housing NIST radio stations:
  - Ft. Collins; 390 acres
  - Kauai; US Navy 30 acre site

NIST FY 2012 Congressional Appropriations
$750M

- Scientific and Technical Research Services
- Industrial Technology Services
- Construction of Research Facilities

Plus
~ $100 M from other Government Agencies
~ $50 M for other reimbursable services

.... and five joint institutes

- JILA – applied physics
- JQI – quantum science
- IBBR – biotech
- HML – marine science
- NCCOE – cybersecurity
The importance of standards

Article I, Section 8: The Congress shall have the power to...fix the standard of weights and measures

By the early 1900’s, increasing commerce and improved quality of life required “National Standards”

- Eight different “authoritative” values for the gallon
- Electrical industry needed standards
- Consumer products and construction materials uneven in quality and unreliable
- American instruments sent abroad for calibration

Estimated that 80% of global merchandise trade is influenced by testing and other measurement-related requirements of regulations and standards
National Institute of Standards and Technology (NIST)

- Non-regulatory agency within U.S. Department of Commerce
- Founded in 1901 as National Bureau of Standards

*Unique Mission within the Federal Government*

...to promote U.S. innovation and industrial competitiveness by advancing measurement science, standards, and technology in ways that enhance economic security and improve our quality of life.

**Constitution of the United States of America**

Article I, Section 8: The Congress shall have the power to ...coin money, regulate the value thereof, and of foreign coin, and fix the standard of weights and measures.
NIST (NBS) established in 1901

“It is therefore the unanimous opinion of your committee that no more essential aid could be given to
• manufacturing
• commerce
• the makers of scientific apparatus
• the scientific work of Government
• schools, colleges, and universities
than by the establishment of the institution proposed in this bill.”

House Committee on Coinage, Weights and Measures ... on the establishment of the National Bureau of Standards (now NIST) May 3, 1900

Organic Act of 1901; Updated in 2008

Functions and activities of the Institute include:
• custody and dissemination of national standards.
• determination of physical constants and the properties of materials,
• comparison of US national standards with those of other nations
• solutions to measurement and standards problems of other government agencies
• providing (Innovation) assistance to industry
Since our inception, in addition to maintaining the more traditional national standards for measurement, we have focused a significant portion of our research and measurement services activities on addressing contemporary societal needs.
Program Planning

- **How does our mission contribute to national priorities?**
  - relevance
  - impact

- **Examples:**
  - Advanced Communications
  - Advanced Manufacturing
  - Cybersecurity
  - Energy
  - Forensic Science
  - Healthcare
  - Nanotechnology
Capacity Planning

- **What capabilities does NIST need in order to carry out its mission effectively?**
  - Positioning
  - Science & technology drivers

- **Examples:**
  - Bioscience
  - IT and Communication, IT and control convergences
  - Systems engineering
  - Quantum-based measurement
The work in NIST laboratory Program focuses on three primary areas:

- Driving innovation through measurement science
- Accelerating the adoption and deployment of advanced technology solutions
- Providing unique, world-class, cutting-edge research facilities for use by industry and academia
NIST impacts semiconductor manufacturing throughout all its laboratories

Advanced Semiconductor Manufacturing

- Measurement Services
- Documentary Standards
- Fundamental Measurement Research

Dissemination

Intel’s new 22nm tri-gate process

Future 450 mm wafer

Images courtesy of Intel
Partnerships/interactions with the semiconductor industry

- Student Sponsorships
- Technical Advisory Board Members
- Workshops and Conferences
  - Frontiers of Characterization and Metrology for Nanoelectronics
- Standards
- Symposia, Workshops, and Conferences
- NIST Assignee On Site
- Workshops and Conferences
- Collaborative Research
- Advisory Boards and Working Groups
- Emerging Research Materials
- Emerging Research Devices
- RF and A/MS Technologies
- Front End Processes
- Metrology
- Documentary Standards and Measurement Techniques
- Conference and Workshop Leadership (IRW, IRPS, IEDM)
  - Especially in reliability
- Industry-NIST partnership with the NRI
NIST technical advances have broad impact on critical dimension, overlay, and defect metrology by working closely with SEMATECH, U.S. semiconductor manufacturers, and metrology tool designers.

Unique, leading edge facilities and modeling capabilities cover:

- Developing new fundamental reference metrology using world class atomic force microscopy (AFM) facility
- Advancing optical patterned defect inspection for the sub-22 nm manufacturing node and providing specific industry guidance
- Advancing overlay metrology by understanding the use of tailored illumination and spatial frequency control
- Developing leading-edge SEM modeling (including charging effects) for critical dimensions, defects, and contact holes
- Helping the industry extend high throughput optical methods for 193 nm optics, source optimization and optical path engineering
- Developing the statistical basis for hybrid metrology, improved measurement uncertainty using multiple measurement platforms
Reliability of CMOS Devices for Semiconductor Manufacturing

Advanced Device Reliability Expertise and Leadership

Unique device characterization (electrical and analytical) expertise and facilities

• Develop realistic circuit lifetime projections based upon reliability characterization of devices
• Develop a new method to characterize mobility and series resistance of ultra-scaled transistors through the wafer-level geometric magnetoresistance effect to optimize manufacturing processes
• Develop fundamental understanding of noise and random fluctuations in nanoscaled CMOS transistors to define scaling limitations for future manufacturing nodes
• Develop a wafer-level High-Definition Electron Spin Resonance technique: Enables the ultimate spectroscopic identification of individual atomic-scale defects in advanced devices and links them back to specific manufacturing processes – a new NIST IMS project for FY2012. Many orders of magnitude more sensitive than conventional ESR.
NIST adds substantial value to semiconductor manufacturing by unique contributions to measurement science, traceable standards, and consensus building leadership at all stages of the semiconductor manufacturing cycle.

“if we can’t measure it, we can’t make it.”

from www.sia-online.org/public-policy/research-technology/
Thanks for Your Attention

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