Introduction to NIST and it's role in "Promoting U.S. Innovation and Industrial Competitiveness"

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NIST-at-a-Glance

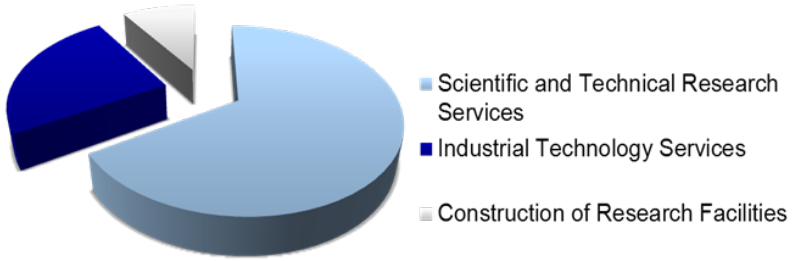
Major Programs

- **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

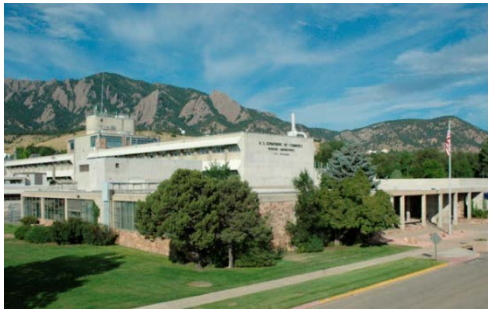
NIST FY 2012 Congressional Appropriations
$750M



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

NIST has two main campuses……

Gaithersburg, MD
55 buildings; 578 acres



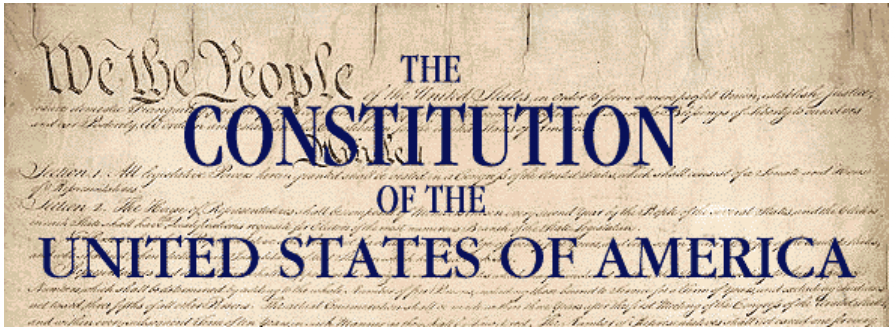
Boulder, CO
26 buildings; 208 acres

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

…. and five joint institutes

- JILA – *applied physics*
- JQI – *quantum science*
- IBBR – *biotech*
- HML – *marine science*
- NCC0E – *cybersecurity*

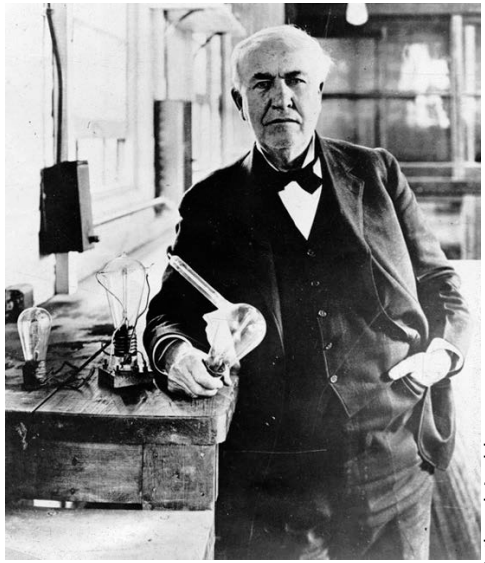
The importance of standards



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

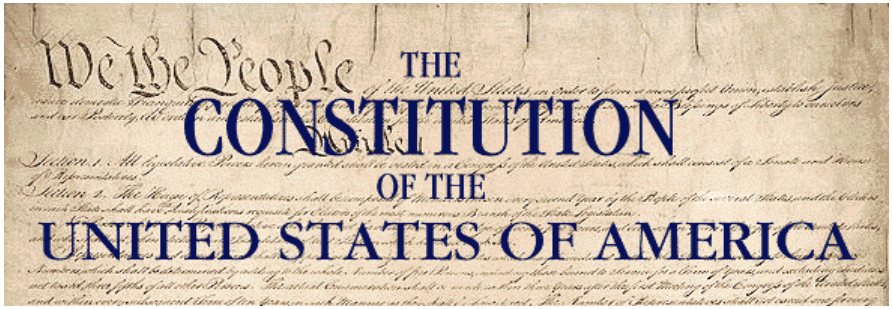


National Archives

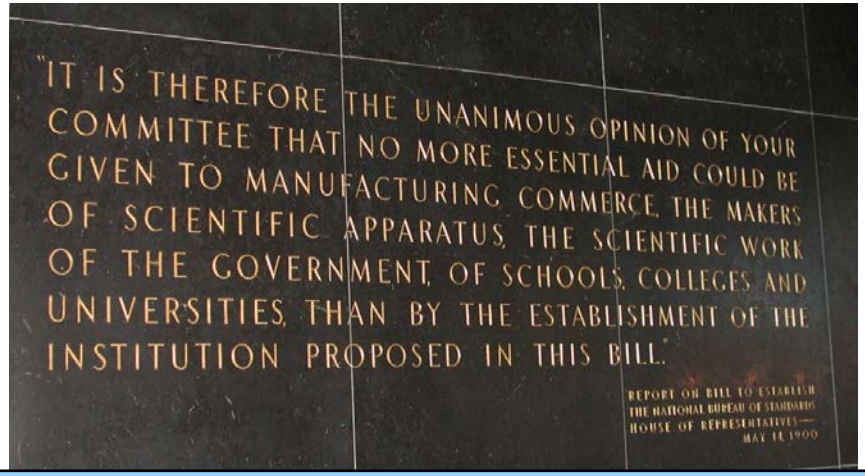
Estimated that 80% of global merchandise trade is influenced by testing and other measurement-related requirements of regulations and standards

National Institute of Standards and Technology (NIST)

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



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*



***Unique Mission within the Federal Government* …**

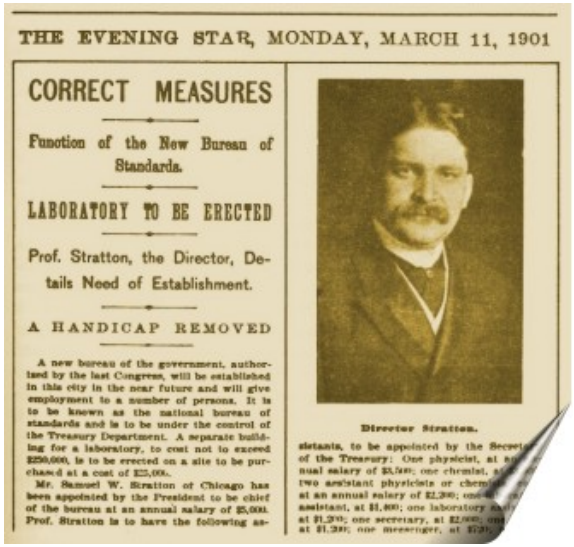
to promote U.S. innovation and industrial competitiveness by advancing measurement science, standards, and technology in ways that enhance economic security and improve our quality of life

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."



THE EVENING STAR, MONDAY, MARCH 11, 1901

CORRECT MEASURES

Function of the New Bureau of Standards.

LABORATORY TO BE ERECTED

Prof. Stratton, the Director, Details Need of Establishment.

A HANDICAP REMOVED

A new bureau of the government, authorized by the last Congress, will be established in this city in the near future and will give employment to a number of persons. It is to be known as the national bureau of standards and is to be under the control of the Treasury Department. A separate building for a laboratory, to cost not to exceed $250,000, is to be erected on a site to be purchased at a cost of $25,000.

Mr. Samuel W. Stratton of Chicago has been appointed by the President to be chief of the bureau at an annual salary of $5,000. Prof. Stratton is to have the following as-

Director Stratton.

sistants, to be appointed by the Secretary of the Treasury: One physicist, at [illegible] annual salary of $3,500; one chemist, at [illegible] two assistant physicists or chemists, at an annual salary of $2,250; one [illegible] assistant, at $1,400; one laboratory [illegible] at $1,200; one secretary, at $2,000; one [illegible] at $1,200; one messenger, at $720;

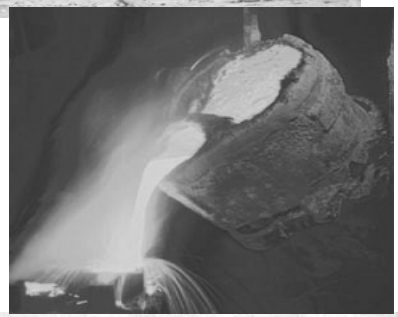
House Committee on Coinage, Weights and Measures … on the establishment of the National Bureau of Standards (now NIST)
May 3, 1900

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.**



1901 . . . 2013

Program Planning

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

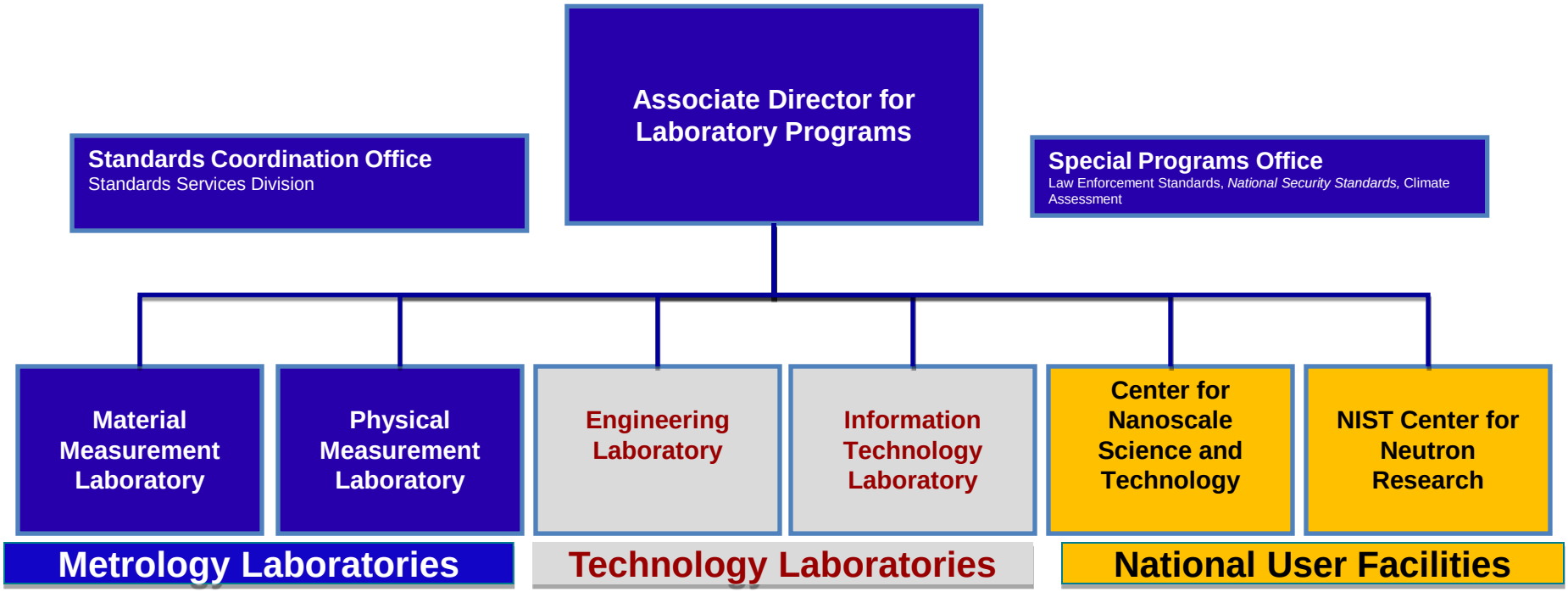
- **Examples:**
  - Advanced Communications
  - Advanced Manufacturing
  - Cybersecurity
  - Energy
  - Forensic Science
  - Healthcare
  - Nanotechnology

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

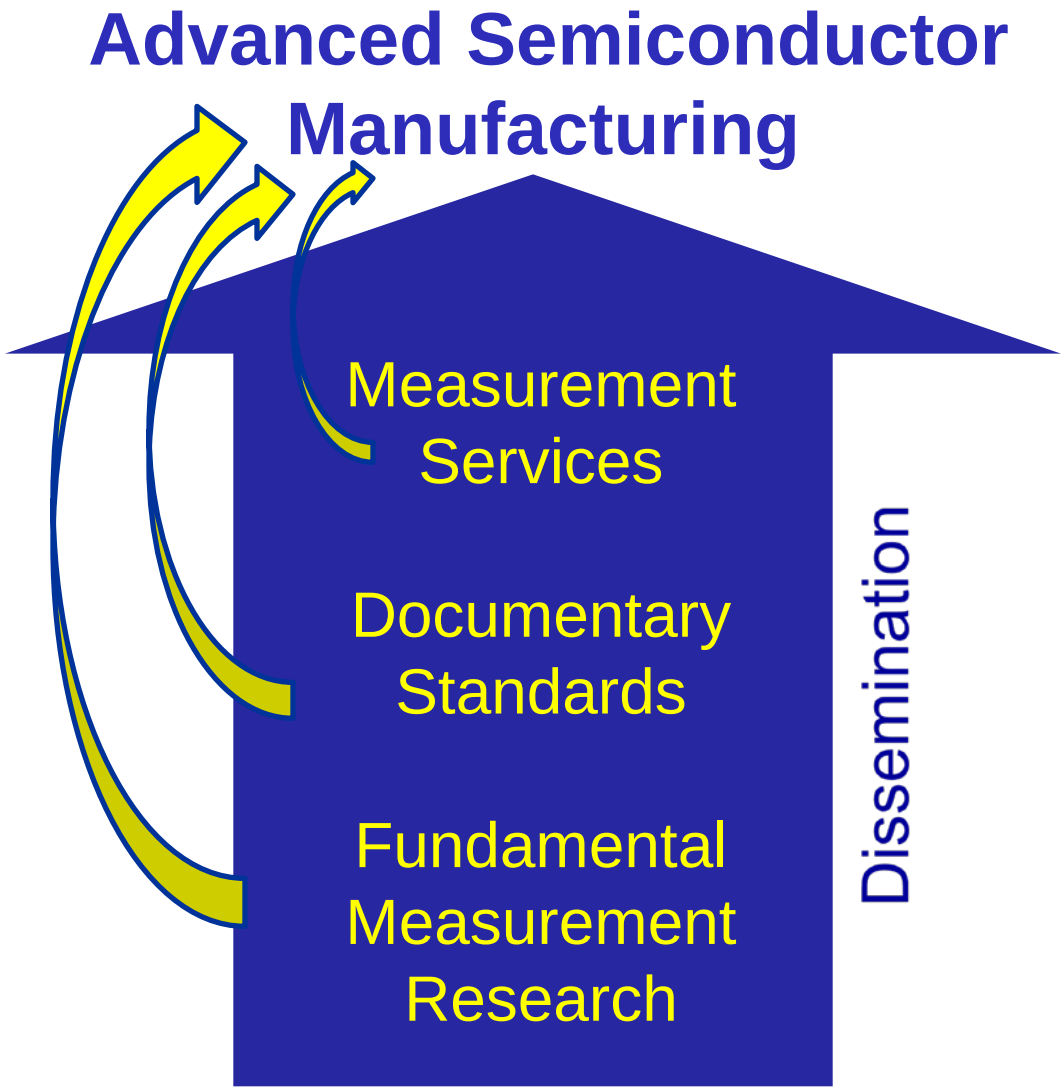
Structure for NIST Laboratory Program

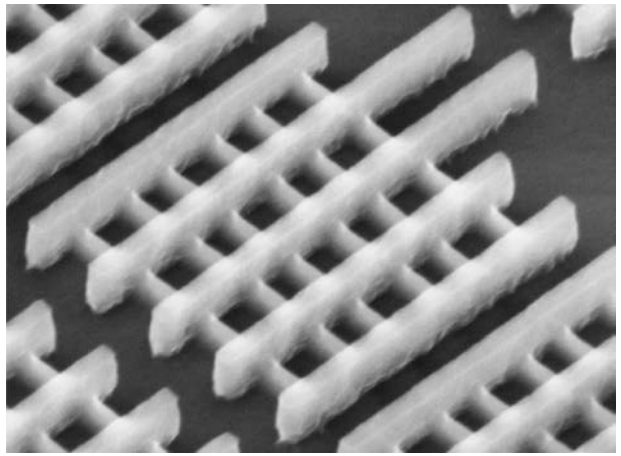


The work in NIST laboratory Program focuses on three primary areas:

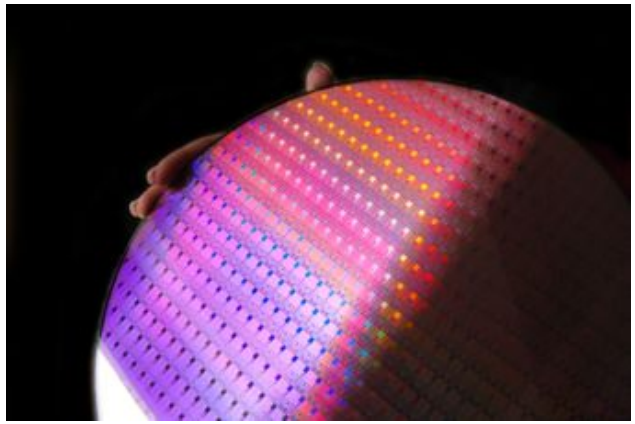
- **Driving innovation through measurement science**
- **Accelerating the adoption and deployment of advanced technology solutions**
- **Providing unique, world-class, cutting-edge research facilities for use by industry and academia**

NIST impacts semiconductor manufacturing throughout all its laboratories





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
- Symposiums, 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

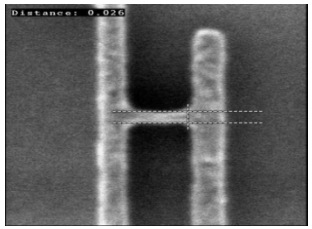
- Documentary Standards and Measurement Techniques

- Conference and Workshop Leadership (IRW, IRPS, IEDM)
  - Especially in reliability

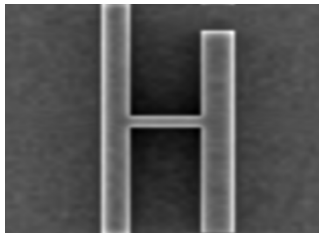
- Industry-NIST partnership with the NRI

Advanced litho-metrology for semiconductor manufacturing:

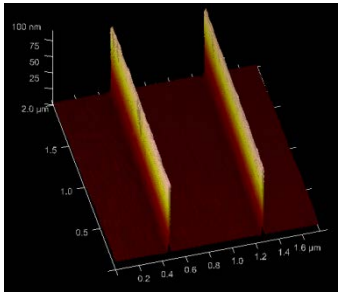
Measuring critical dimensions and defects at and below the 22 nm node



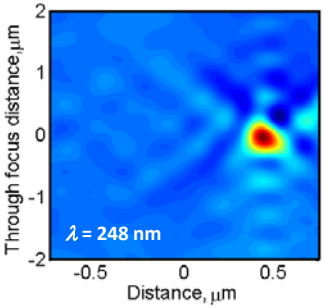
Measurement



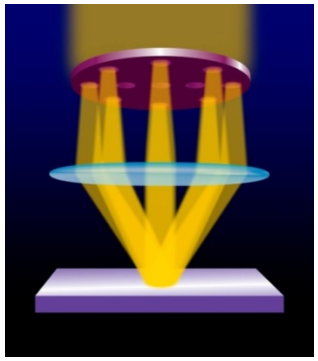
JMONSEL Simulation



AFM image of 10 nm CD line



3-D optical defect detection methods



Illumination engineering

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

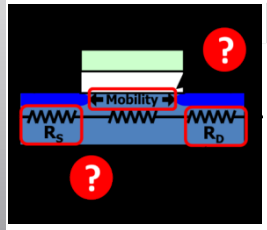
SEMATECH

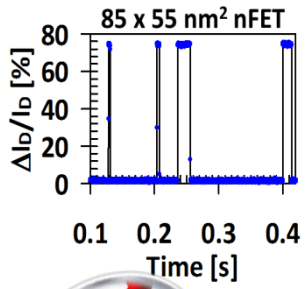
Reliability of CMOS Devices for Semiconductor Manufacturing

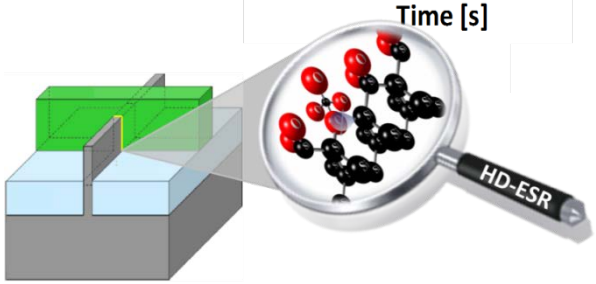
Advanced Device Reliability Expertise and Leadership

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.



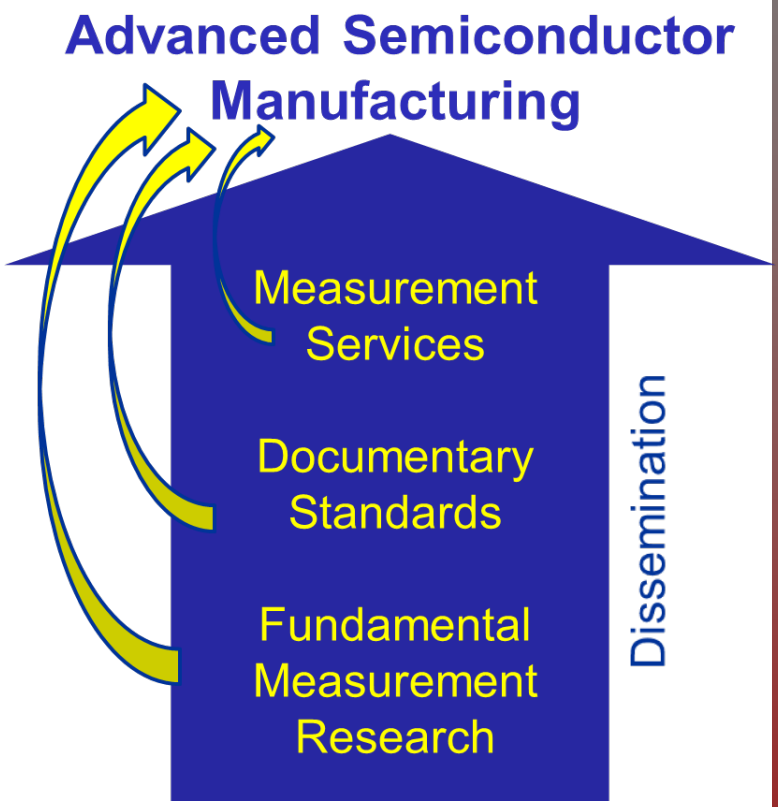




imec
SRC Semiconductor Research Corporation
tsmc
SAMSUNG
GE
intel
Massachusetts Institute of Technology
SEMATECH
Accelerating the next technology revoli
Stanford

Summary

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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