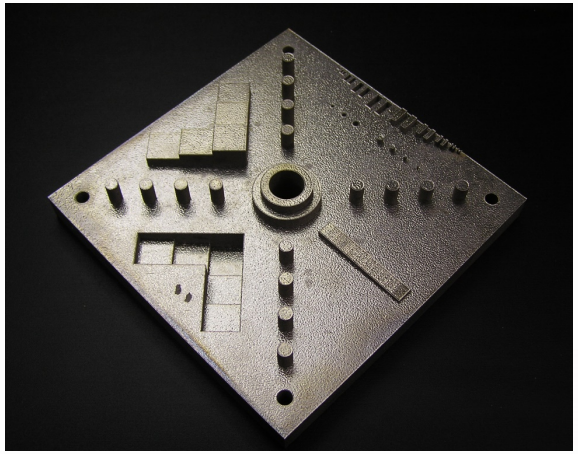
NIST AM Research Supporting Measurement Science and Standards



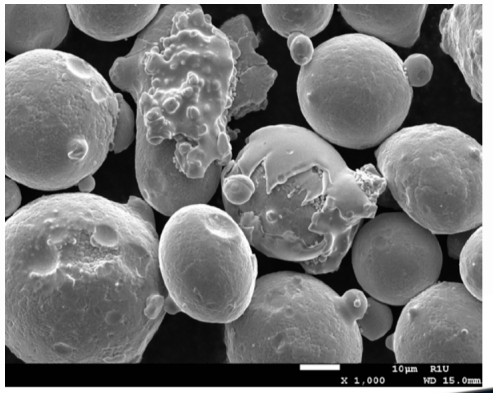
Shawn Moylan

Mechanical Engineer / Project Leader

Intelligent Systems Division

Engineering Laboratory

National Institute of Standards and Technology



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

National Institute of Standards and Technology (NIST)

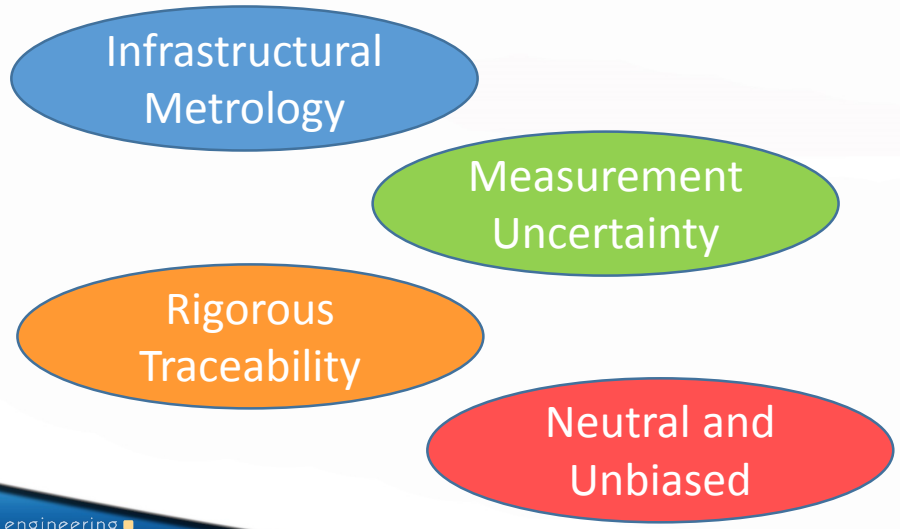
- Federal agency in U.S. Department of Commerce
- National Metrology Institute for the United States
- NIST Mission:

  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 and Manufacturing

"It is therefore the unanimous opinion of our committee that no more essential aid could be given to manufacturing […] than by the establishment of the [National Bureau of Standards]."

U.S. Congress committee, May 1900



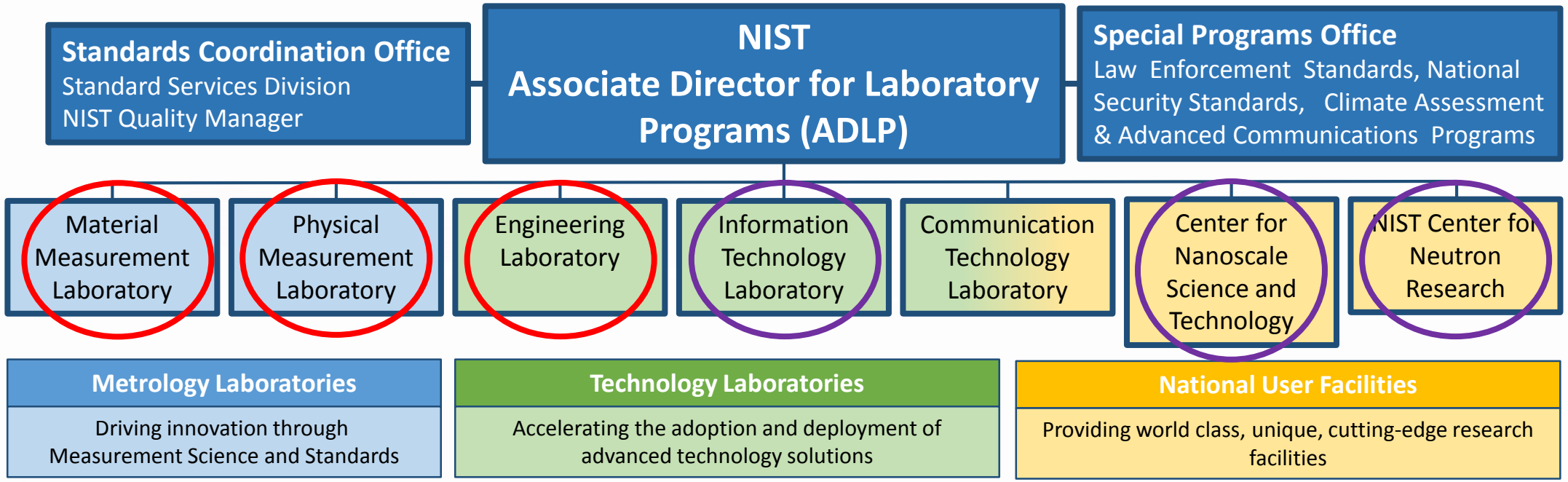
A partner to US manufacturers for more than a century, NIST helps the nation's manufacturers to invent, innovate, and create through:

- **Measurement science** – manufacturers and technology providers use NIST test methods, measurement tools, performance measures, and scientific data every day
- **Advanced materials** – NIST is building a materials infrastructure to accelerate the timeline from design to deployment of new materials
- **Standards development** – NIST provides the scientific and technical basis for many voluntary consensus standards
- **Partnerships** – collaborations with the private sector and academic organizations help advance and disseminate research and support US manufacturers

➢ **Measurements and Standards**

NIST Overview

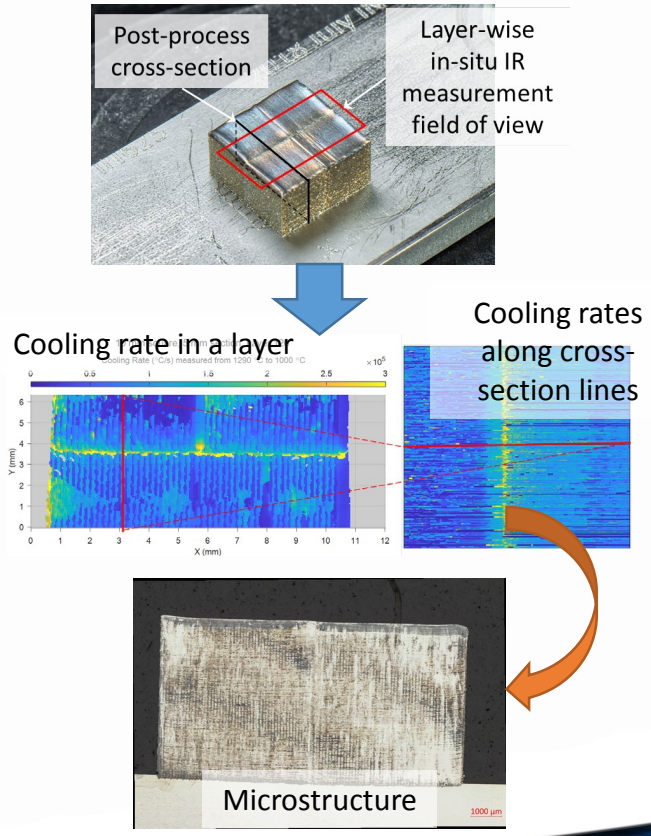
- **NIST research in measurement science and standards for additive manufacturing will enable the predictable and repeatable performance of additively manufactured components.**



3 Laboratories leading AM research **3 Laboratories supporting AM research**

NIST AM Research

- Full spectrum of materials classes (Ceramics, Polymers, Metals, Concretes, Biological materials)
- Full spectrum of AM process categories
- Focus areas:
  - Unique materials and material properties
    - Comprehensive characterization of processing-structure-properties-performance (PSPP) relations
    - Determination of properties affecting printability/manufacturability
    - Provisionment of critical AM materials data to stakeholders
    - Methods to enable the insertion of new materials for additive applications
  - Trustworthy in-process monitoring and control
  - Verified and validated process and material models and design tools
  - Rapid, inexpensive, and effective part inspection techniques
  - Rapid and traditional machine and material qualification techniques
  - Process and material standards and specification



EL MSAM program structure

Objective: To develop and deploy measurement science that will enable rapid design-to-product transformation through advances in: material characterization; in-process process sensing, monitoring, and model-based optimal control; performance qualification of materials, machines, processes and parts; and end-to-end digital implementation of metal Additive Manufacturing processes and systems.

Data Integration and management for AM

Models, methods and best practices for data management, data integration and fusion in AM

Data driven decision support for AM

Metrics, models, and best practices for using product definition, **advanced analytics, and machine learning methods in** AM design and process planning

AM Precursor Material Qualification

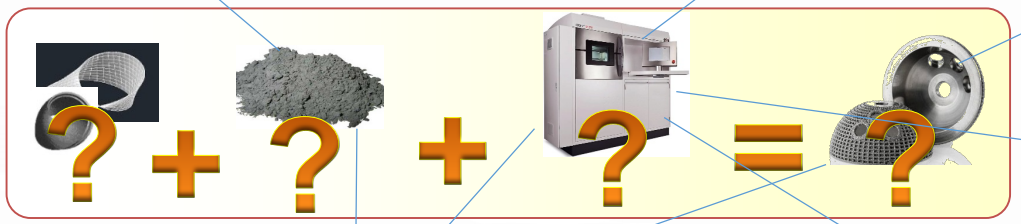
Methods of characterizing the precursor materials to enable their optimum use

AM Machine and Process Qualification

Test methods, protocols, and data to reduce the cost and time needed to qualify metal AM machines and processes

AM Part Qualification

Test methods and protocols, standard test artifacts, data, and data processing tools for robust post-process measurements



AM Machine and Process Control Methods

Algorithms, methods, and standard protocols for Additive Manufacturing (AM) process control, and software and hardware tools for open control of AM systems

Metrology for Multi-Physics AM Model Validation

Reference data for the validation of models of metal additive manufacturing processes

Metrology for Real-Time Monitoring of AM

Metrology methods, tools, data, and standards for in-situ monitoring of AM processes

NIST Influence on Additive Manufacturing Standards

- Identify consensus needs and priorities for standards
  - Workshops, industry meetings, outreach events, etc.
- Conduct measurement science research to develop technical basis for standards
  - Draft content / starting point for development of documentary standards
- Serve on standards committees
  - Leadership roles
  - Technical standards development
  - Strategic planning / big picture view
- Support the coordination, facilitation, and communication among standards groups

Multiple Standards Bodies are Relevant to Additive Manufacturing

- ASTM Committee F42 on Additive Manufacturing Technologies
- ISO Technical Committee 261 on Additive Manufacturing
- SAE Aerospace Material Specifications for Additive Manufacturing (AMS-AM)
- ASME Y14.46 on Geometric Dimensioning & Tolerancing (GD&T) Requirements for Additive Manufacturing
- ASME B46 Project 53, Surface Finish for AM
- AWS D20 on Additive Manufacturing
- ISO TC184 / SC4, STEP-based data representation for AM
- <others – the **AM Standards Landscape continues to grow**!>

NIST Contributes to All of These Efforts

Additive Manufacturing Standards Collaborative (AMSC)

- Open Gaps in Standards Landscape

Section	High (0-2 years)	Medium (2-5 years)	Low (5+ years)	Total
Design	4	15	6	25
Precursor Materials	1	4	4	10
Process Control	4	8	4	16
Post-processing	0	4	3	7
Finished Material Properties	3	1	0	4
Qualification & Certification	4	8	3	15
Nondestructive Evaluation	2	4	2	8
Maintenance & Repair	0	7	1	8
Total	18	51	24	93

  - 65 gaps need Research & Development

Final Thoughts

- Implementing AM, especially through qual/cert, is primarily about risk. Measurement science and standards help quantify and reduce that risk.
- An integrated and cohesive set of standards that is consistent, non-contradictory, and non-overlapping will not only improve AM commerce, it will shorten the AM learning curve.
- Robust participation in standards development is essential. Your ideas, expertise, and help are welcomed and appreciated!

Questions and Discussion

Contact:

Shawn Moylan

shawn.moylan@nist.gov

Telephone: (301) 975-4352

www.nist.gov/topics/additive-manufacturing

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