Manufacturing a New Paradigm

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Advanced Naval Materials and Systems Division Director

ACCELERATING TO THE NAVY & MARINE CORPS AFTER NEXT


“What the future Navy will be like, we cannot say as yet.”
Chief of Naval Operations Fleet Admiral Chester Nimitz

Naval Research Enterprise

Organizational Milestones

1946

ONR London Office created to survey, assess, and report on European Science and Technology

Office of Naval Research (ONR) established

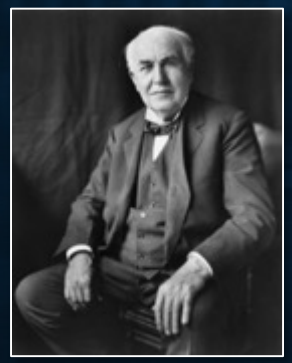
1993

ONR becomes a 6.1-6.3 organization

2009

ONR Global designated as an Echelon II Command reporting to CNR

1920 1930 1940 1950 1960 1970 1980 1990 2000 2010 2020



July 2, 1923

Naval Research Laboratory (NRL) established at the recommendation of Thomas Edison

1974

ONR's first international office outside of Europe is established in Tokyo

2003

Naval Fleet/Force Technology Innovation Office and International Field Office merged to form **Office of Naval Research Global (ONR Global)**

2022

NavalX designated as an Echelon II Command reporting to CNR

ONR is headquartered in Arlington, VA sponsoring facilities in the US and abroad.

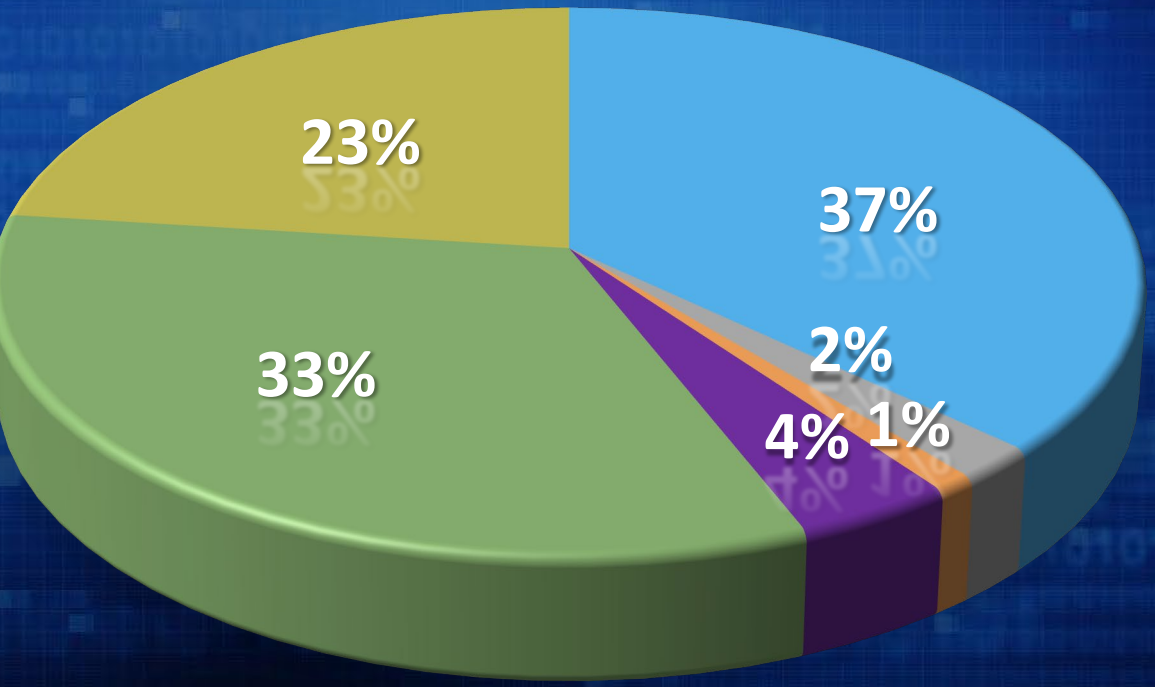
NRL is headquartered in Washington, DC with four field sites in the U.S.

ONR Global is headquartered in London with 19 locations over five continents.

The Naval Research & Development Establishment (NR&DE)

The Naval Research Enterprise

ONR Portfolio Investment



- 6.1 Basic Research
- 6.2 Applied Research
- 6.3 Advanced Technology Development
- 6.4 Advanced Component Development and Prototypes
- 6.6 Management Support
- 6.7 Operational System Development

ONR Research Portfolios

Command, Control, Computing, Communications, Cyber, Intelligence, Surveillance, Reconnaissance and Targeting

Sea Warfare and Weapons

Warfighter Performance

Ocean Battlespace Sensing

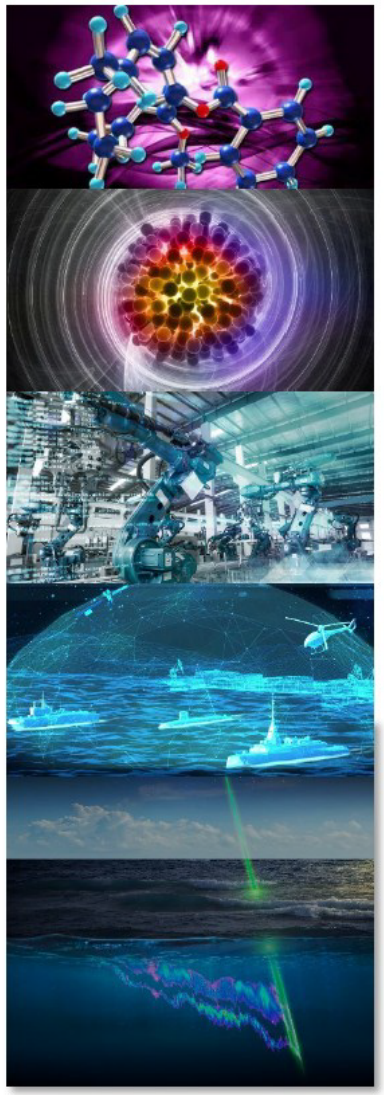
Naval Air Warfare and Weapons

Sea Warfare & Weapons

Sea Warfare & Weapons Focus Areas

Develop and deliver knowledge, talent, and technologies that enable unconstrained Naval missions

Delivering What is Needed / Where it is Needed / When it is Needed



Materials - *enable mission capabilities through multifunctional materials*

Objective: provide integrated multi-functional material systems that are self-aware and self-adjusting for the Department of Navy by employing a function-driven material discovery and design approach.

Power & Energy - *Naval missions unconstrained by power and energy*

Objective: provide revolutionary, game-changing capabilities in power & energy generation, storage, distribution, thermal management, and control.

Manufacturing - *resilient intelligent manufacturing for Naval missions at all sizes and time horizons*

Objective: provide advanced manufacturing technologies from design to sustainment utilizing a foundation of manufacturing science and technology to accelerate development and deployment.

Ocean Science and Technology - *enable asymmetric advantage in all environments*

Objective: provide applied ocean science and technologies to advance naval missions in the maritime environment.

Naval Engineering - *reliably create effects anytime and anywhere*

Objective: provide scientific and engineering foundations to fully exploit physical phenomena and virtual environments.

Undersea Lethality - *unconstrained undersea lethality*

Objective: ensure asymmetric capabilities to reliably create and counter undersea lethal effects.

Manufacturing

Dr. Jenn Wolk

Manufacturing - *resilient intelligent manufacturing for Naval missions at all sizes and time horizons*

Objective: provide advanced manufacturing technologies from design to sustainment utilizing a foundation of manufacturing science and technology to accelerate development and deployment.

Challenges:

- How do you manufacture to scale from a microchip to a platform in the time frame and rate that you need it - *integration with design tools*
- How do you increase manufacturing resiliency – *scale problem*
- How do you make a high fidelity lifecycle model - *integration with design tools*

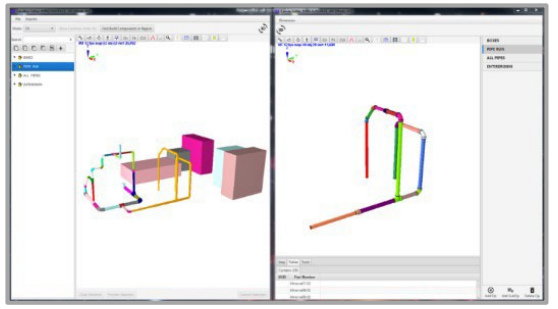
Research Areas
Manufacturing Focus Area

ManTech
- Advanced manufacturing enterprise technologies
  - Digital thread/ digital twin, AI/ML
- Composites and non-metallic materials
  - Coatings, insulation, transparencies
  - Polymers
  - Ceramics
- Electronics and Electro-optics
- Energetics
- Metalworking
  - Welding, castings, forgings, processing
  - Automation, and robotics

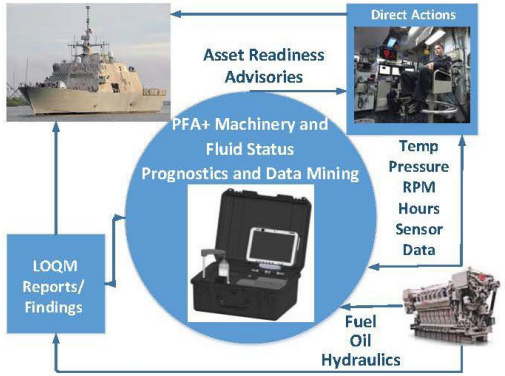
Sustainment Technologies
- Condition based maintenance (CBM)
- Corrosion control technologies
- Repair technologies

Manufacturing S&T
- Materials and processes for additive manufacturing
  - Processing at multiple scales
  - In-line sensing and analysis
  - Tools for confident performance prediction and rapid qualification
- Manufacturing capability acceleration

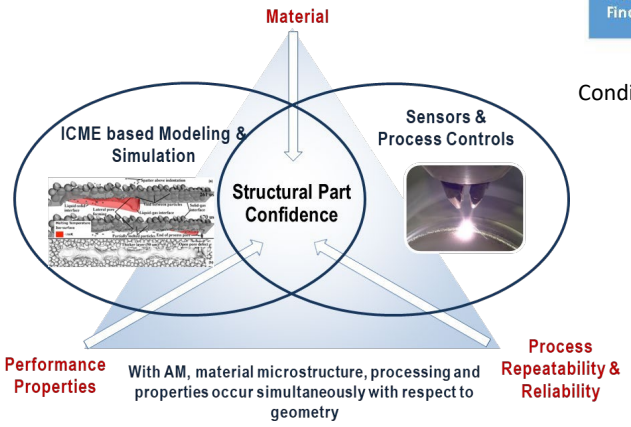
Robotic Shaping of Steel Plates for Shipbuilding



Model Based Build Plan for Shipbuilding Optimization

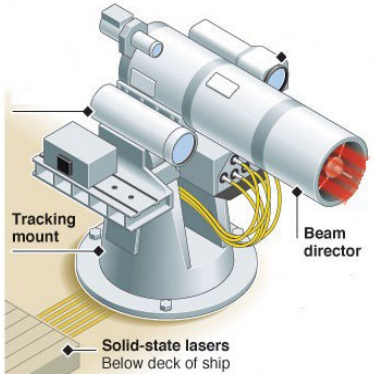


Condition based maintenance from fluid analysis

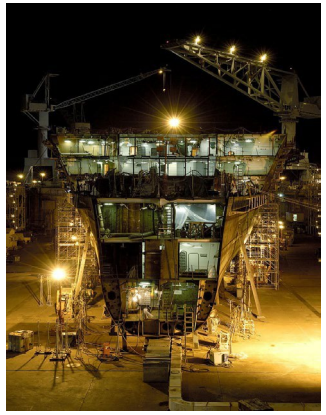


Cold Spray Repair

Multi-scale metamorphic manufacturing technology demonstrated for production of conical forms with drag-reduction riblet features for UUV applications



Developing Manufacturing Processes for Key High Energy Laser Components

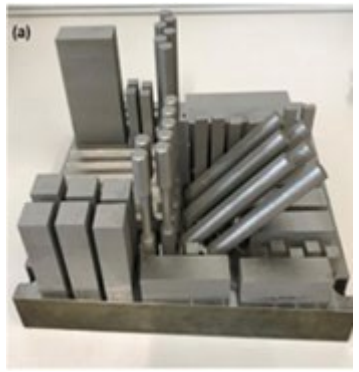


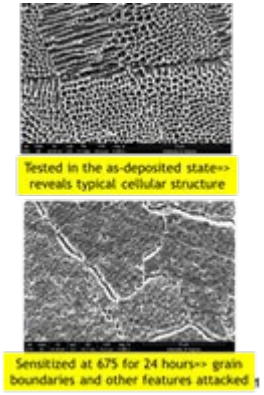
Shipbuilding construction

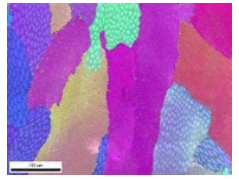
Research Areas
Materials Focus Area

Research Areas:

- Acoustic transduction materials and devices
- Computer-aided materials design
- Benign antifouling and fouling release materials
- Corrosion science and corrosion control technologies
- Dielectric materials and films
- Electrochemical materials
- Functional polymeric and organic materials
- Materials and processes for additive manufacturing
- Materials for thermal and chemical extremes
- Nano-engineered materials
- Non-destructive evaluation and prognostics: advanced sensors and technologies
- Nonlinear physics
- Organic photovoltaics
- Polymer matrix composites
- Propulsion materials
- Structural metals
- Water treatment/reduction and analysis

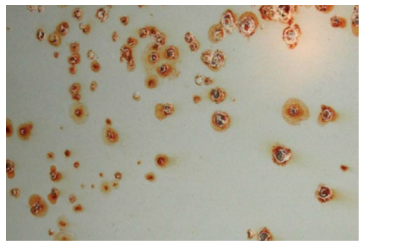




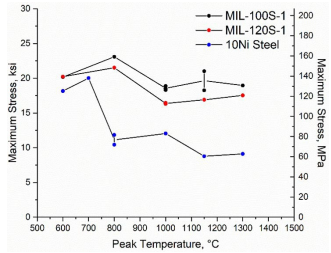


AM 316L, Near Center of Build

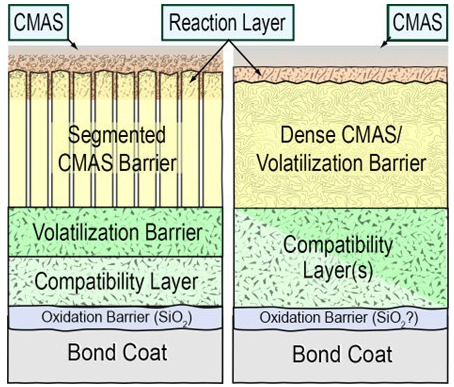
Corrosion is pervasive for almost every Navy/USMC asset in potential operational/mission environments.



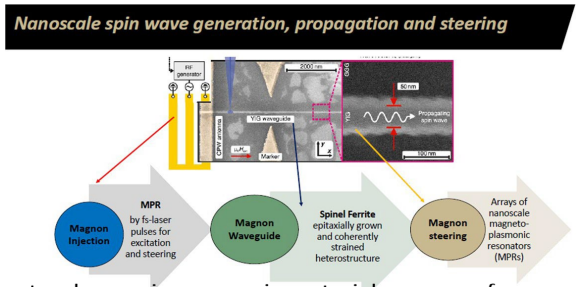
Coating showing about 5% breakdown



New 10%Ni weld consumable being developed at NSWC-CD shows significant decrease in weld metal residual stress relative to legacy naval weld metals.



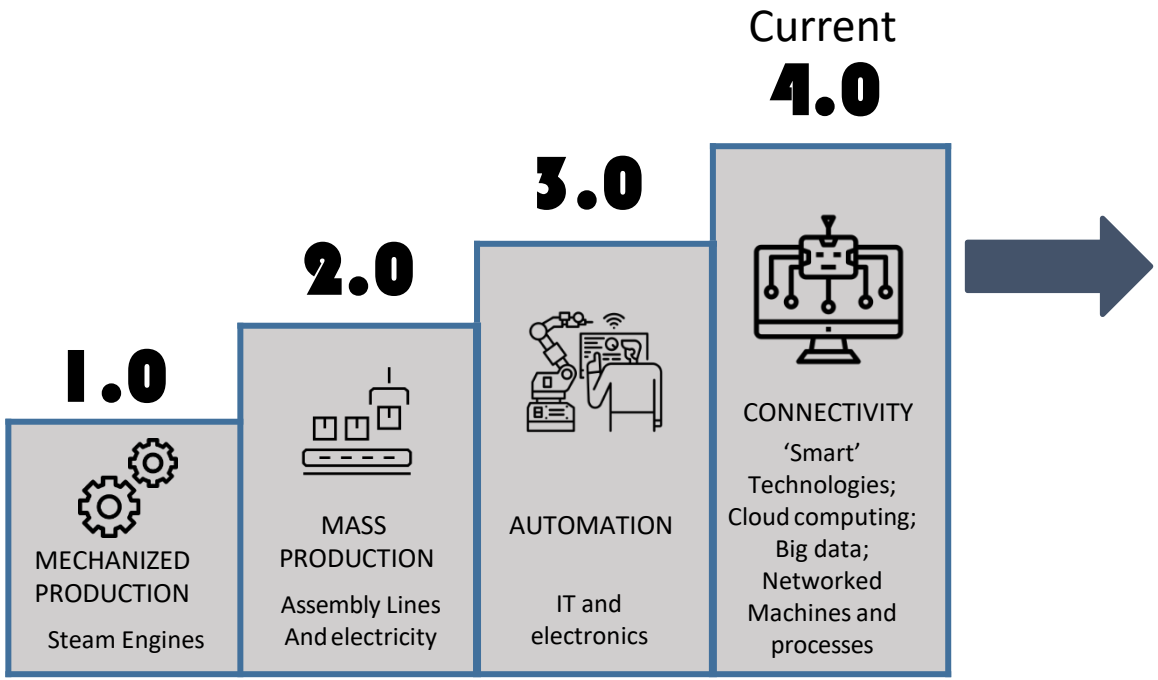
HPT Stage 2 Nozzle (vane), Airfoil



A magneto-plasmonic-magnonic material response for generating and transporting spin waves without dissipation for fast chip-based logic and memory.

E. Marinero-Purdue U.

Manufacturing the Future



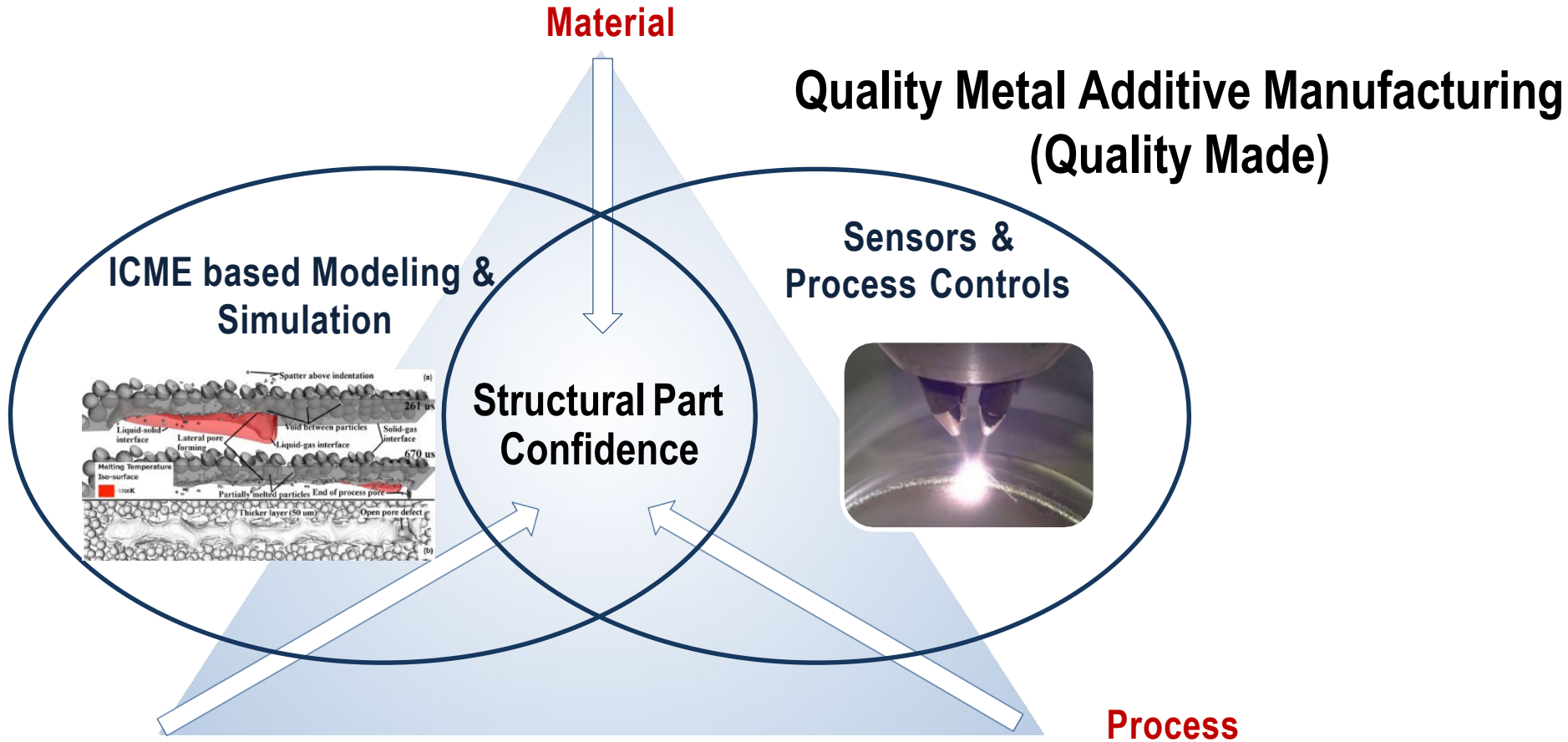
5.0

Man-Machine cooperative learning/optimization in smart manufacturing

Technology → Value

Navy S&T to capitalize on Industry 5.0 and beyond
High Mix/High Volume

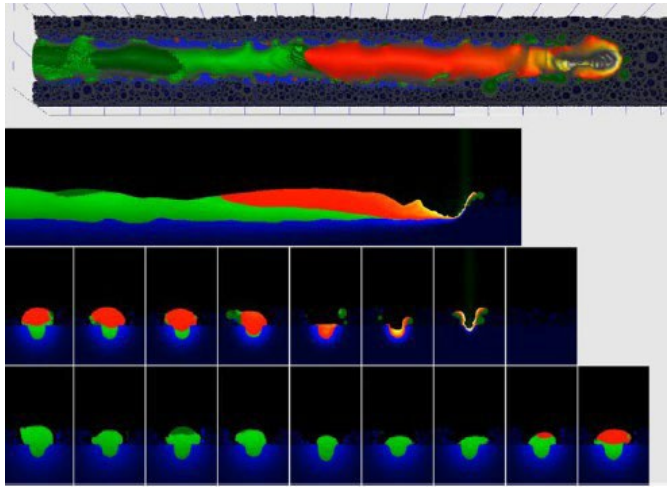
Changing the Qualification Paradigm



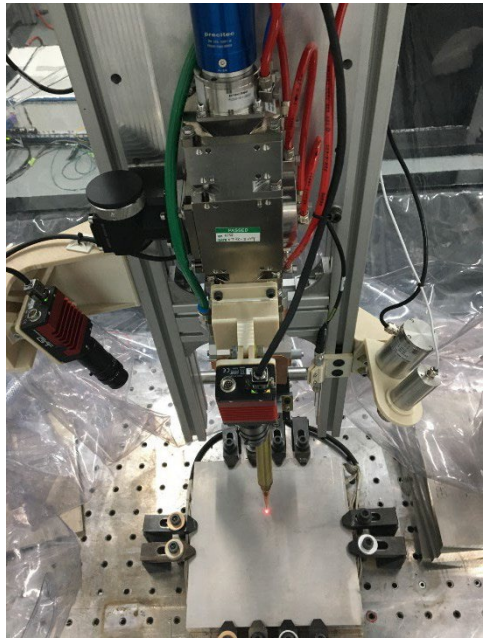
Informing Qualification

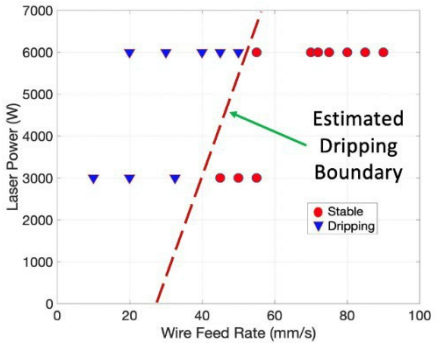
Process

Models

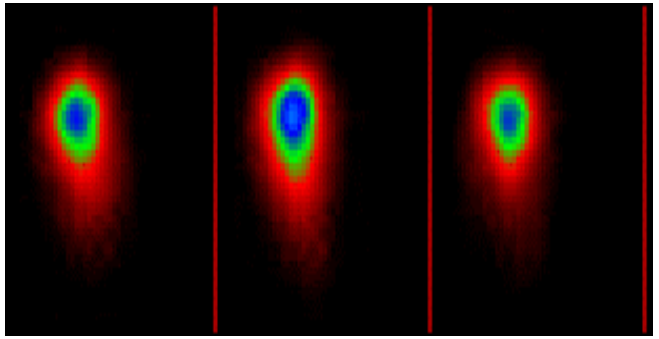


- Local, detailed insights
- Subsurface
- Length & solidification behavior





Sensors

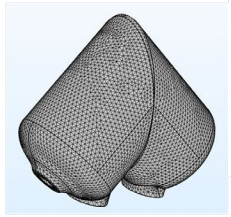


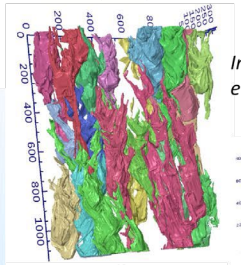
- Rapid, simple insights
- Isolate shifts in process
- Stability

Implementing Additive Manufacturing

Rowenhorst (6356)

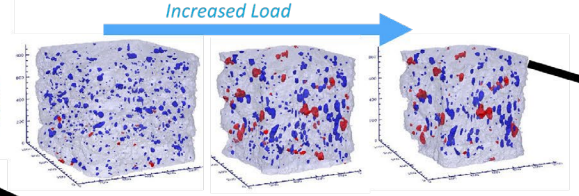
Advanced 3D characterization links complex grain shapes and defect populations to processing history

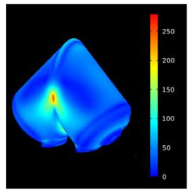




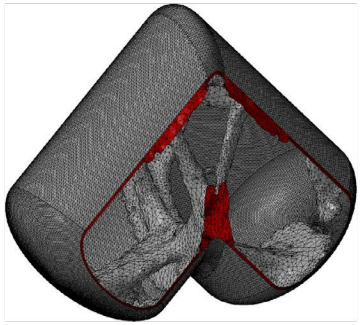
NRL RS^{3D} AM Grain Structures

In-situ CHESS synchrotron X-ray tomography examines defect evolution under plastic strain.



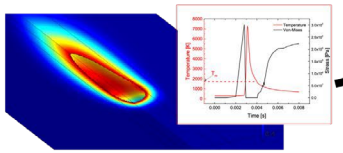


Microstructure/processing informed top-op/performance model

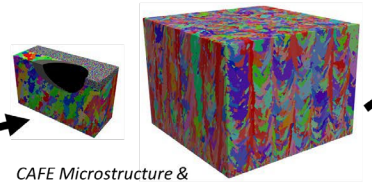


Topology optimized design:
10% more mass
250% increase in total allowable pressure.

Michopoulos et al (6394)



AM path dependent thermo-mechanical modeling



CAFE Microstructure & Crystal Texture modeling

Taferra (6353)

Multi-physics models informed and validated with characterization predict performance.

Michopoulos et al (6394)