Additive Manufacturing @ CEET – NIU

Federico Sciammarella PhD
Associate Professor Mechanical Engineering
College of Engineering & Engineering Technology

http://niu.edu/ceet/Facilities/ARMM.shtml

Additive Manufacturing Market

- The Compound Annual Growth Rate has grown from 24.1% in 2010 to 35.2% in 2014.
- This puts the AM industry in terms of products and services worldwide up to $4.103 billion, the largest growth in 18 years.
- This values does not include investments in R&D as it is difficult to track.
- R&D focus to improve repeatability and quality
  - America Makes, GE, Lockheed, Raytheon, UTC etc…

*From Wohlers Associate report 2015

Metal Additive Manufacturing Market

Revenue from metals for additive manufacturing grew 49.4% in 2014 to an estimated $48.7 million, up from $32.6 million in 2013 and $24.9 million in 2012.

*From Wohlers Associate report 2015 – largest growing market in AM

Learn more at

NIST-MSAM NIU EDUCATIONAL VIDEO (Part I)

Conventional Manufacturing vs AM

Conventional

Start with a pre-formed billet, which gets formed and machined.

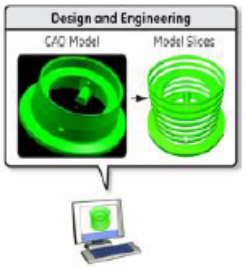
Material properties unchanged and cannot be location specific

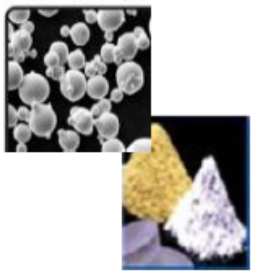
Limited to known set of geometries

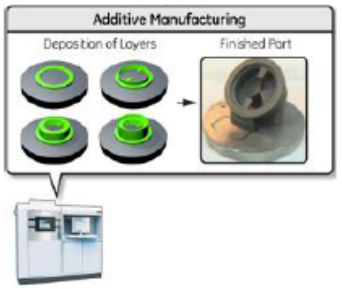
Design constrained by manufacturing

Requires extensive tooling

Additive







Start with a powder or wire and produce part layer upon layer upon layer.

Build material properties as part is built … location specific

More complex geometries possible

Allows for faster iterations between design, materials and manufacturing

Minimal tooling required

Material properties created during manufacturing
→ Ability to tailor by location

AM Pays When:

1. Conventional methods fail
   - Buy-to-fly ratio is high
   - Too thin or intricate to cast, machine, or forge
2. Assemblies can be replaced with single parts
3. Tooling costs are not acceptable
   - Required quantities are low
   - Time is critical
   - Each part is different

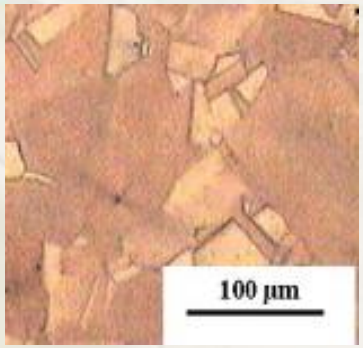
NIU ARMM lab – LENS Upgrade

Objectives:

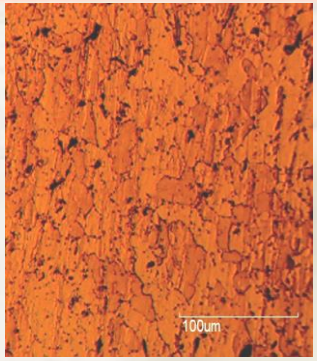
- Create world class laboratory in metal additive manufacturing (MAM) for research and to support local industry using AM
- Ensure MAM exposure to all CEET students

http://niu.edu/ceet/Facilities/ARMM.shtml

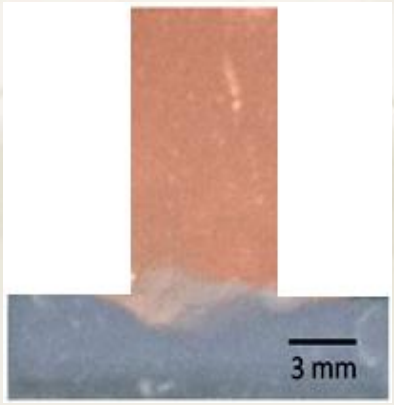
AM – Copper & Tool Steels (H13)



11000 Cu – wrought
Grain size ~ 100 µm



11000 Cu – LENS
Grain size ~ 20 µm

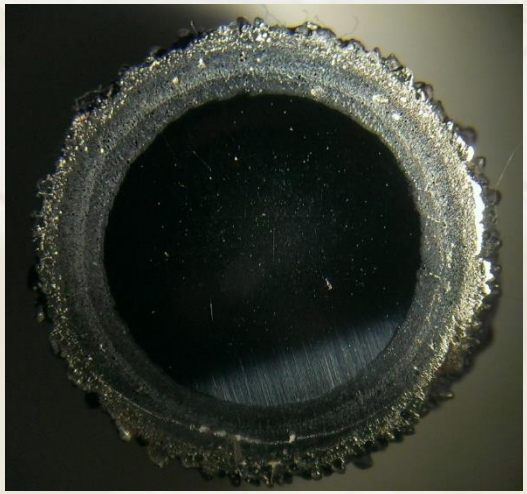


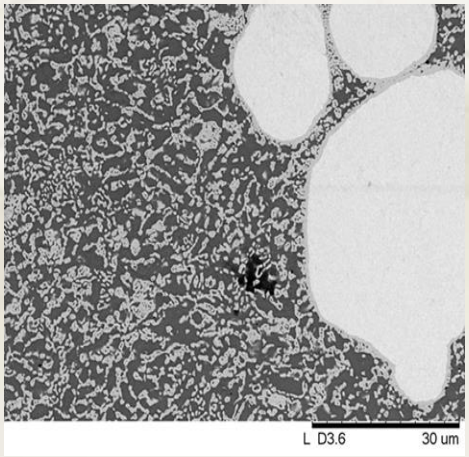
- We built a 12 cubic mm volume of copper onto a steel substrate, with a 10× increase of deposition rate better than industry
- Worked with OSU & NADCA as a sub for a DOE contract to be only ones to successfully deposit tool steel directly on Cu to simulate injection molds to reduce cycle times when making parts
  - part cooling takes up 50 to 80 % of the cycle time

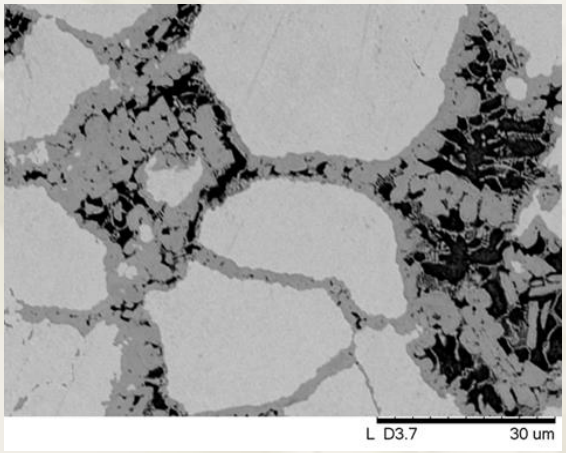
Outcome

10k Funding for Project – OSU
1 MS Thesis

Tungsten on tool steel (DoD)







- Preliminary results led to a DoD contract but funding was limited.
- Still lots of interest in W alloy
- **140k Funding for Project – DoD**

Northern Illinois University – NIST MSAM

Physics-Based Additive Mfg. Models For Process Control & Quality Assurance

Project Objectives

- A comprehensive suite of integrated tools for process control and Additive Manufacturing part qualification
- Devise and test models that enable predictive process adjustments during the layer-by-layer, three-dimensional manufacturing method
- Guide development of customized engineered materials tailored to the capabilities of specific AM technologies, eliminating much trial-and-error testing

•Collaborators:

- Northwestern University, Evanston, Ill.
- Quad City Manufacturing Laboratory, Rock Island, Ill.
- Illinois Manufacturing Excellence Center, Peoria, Ill.
- Fabricators & Manufacturers Association, International, Rockford, Ill.
- ASM International

http://www.niu.edu/ceet/msam/

•Outcomes:

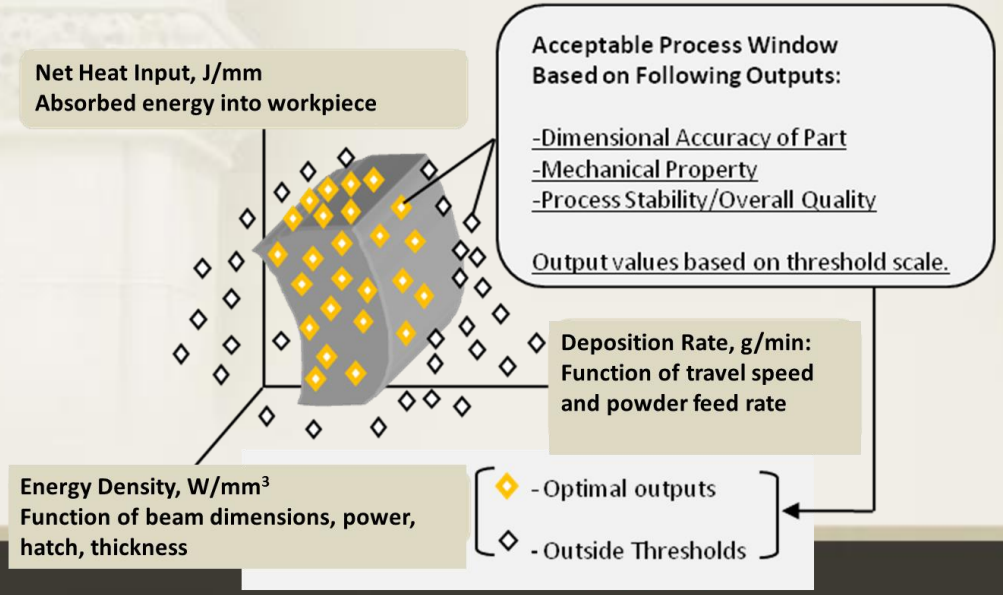
- **At least 12 undergraduates have or are working in program**
- **1 M.S. Degree (3-4 more expected)**
- **1 MS employed at NIST**
- **1 BS/MS to intern at NIST**
- **Three potential patents**

Project End Workshop

Measurement Science for Additive Manufacturing
NIST Award: 2013-2016
Project Close-Out and Summary of Results
Project Team: Northern Illinois University, Northwestern University, Quad City Manufacturing, ASM, FMA, IMEC

Followed by:
NIST Workshop on Measurement Science for Directed Energy Deposition

May 23-24, 2016
2133 Sheridan Road – Ford Motor Company Engineering Design Center
Evanston, Illinois 60208 - map



Past and present Opportunities

- UIC (opthomolagy)
- U of I
- Northwestern – DMDII
- XLE
- IMS (international)
- QuesTek
- CSIR
- UNAM
- ONR – QUALITY MADE
- Oxergy (Navy, NSF)
- ENABLE