Physical Metallurgy and Materials Design Laboratory

Wei Xiong

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2016-present, University of Pittsburgh, Assistant Professor
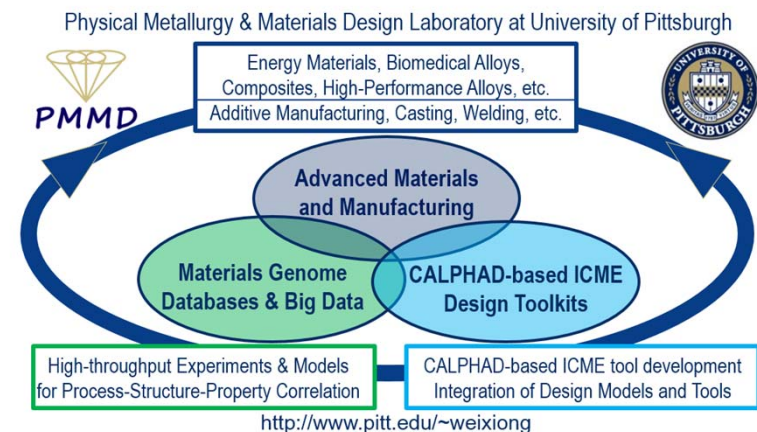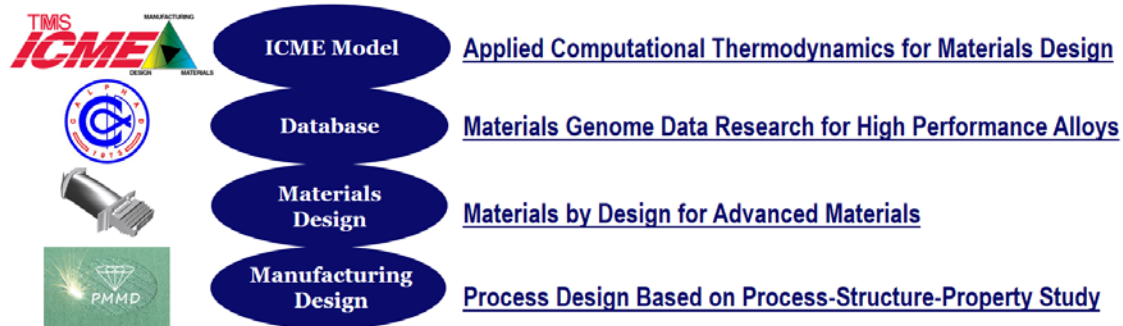
2013-2016, Northwestern University; Postdoc

2012-2013, University of Wisconsin – Madison; Postdoc

2008-2012, KTH Royal Institute of Technology, Sweden; Ph.D.

2005/12-2006/3, University of Vienna, Austria; visiting scholar

Physical Metallurgy and Materials Design Laboratory

- Advanced Materials and Manufacturing
- Fundamental Research in Physical Metallurgy
- Bridge Improved Fundamentals and Engineering Applications

ICME Model	Applied Computational Thermodynamics for Materials Design
Database	Materials Genome Data Research for High Performance Alloys
Materials Design	Materials by Design for Advanced Materials
Manufacturing Design	Process Design Based on Process-Structure-Property Study

Physical Metallurgy & Materials Design Laboratory at University of Pittsburgh

Energy Materials, Biomedical Alloys, Composites, High-Performance Alloys, etc.
Additive Manufacturing, Casting, Welding, etc.

Advanced Materials and Manufacturing

Materials Genome Databases & Big Data

CALPHAD-based ICME Design Toolkits

High-throughput Experiments & Models for Process-Structure-Property Correlation

CALPHAD-based ICME tool development Integration of Design Models and Tools

http://www.pitt.edu/~weixiong

| 26 Fe Iron 55.933 | 27 Co Cobalt 58.933 | 28 Ni Nickel 58.693 | 22 Ti Titanium 47.88 | 12 Mg Magnesium 24.305 | 13 Al Aluminum 26.982 | HEA |

Additive manufacturing of graded alloys

"Integrated Computational Materials and Mechanical Modeling for Additive Manufacturing of Alloys with Graded Structure Used in Fossil Fuel Power Plants"
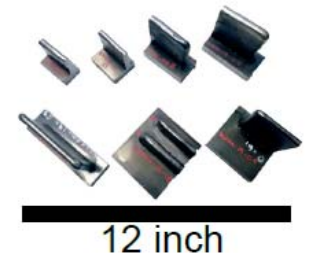PI: Wei Xiong, Co-PI: Albert To (Pitt), Michael A Klecka (UTRC)
 – Sponsor: DOE NETL, Period of Performance: 11/1/2018-10/31/2020
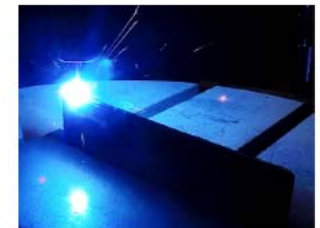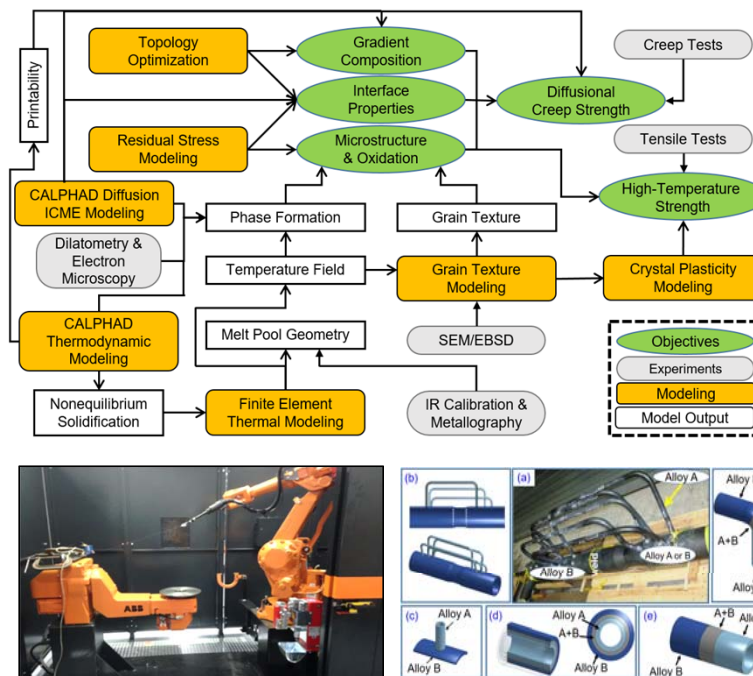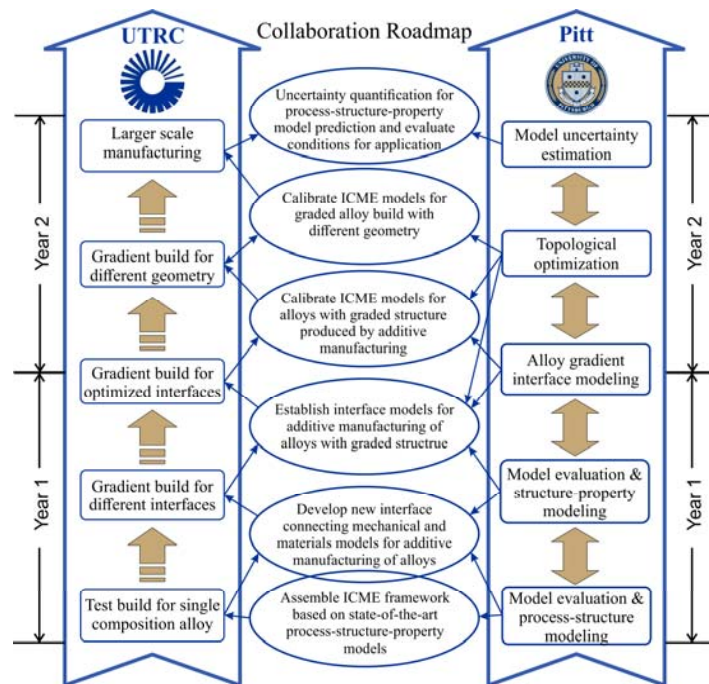
WAAM Building Process

Joint Built T91 with 740H

12 inch

New alloy design for additive manufacturing

"Integrated Computational Materials Design for Additive Manufacturing of High-Strength Steels used in Naval Environments",

– Sponsor: ONR, Period of Performance: 7/1/2017-6/30/2020

✓ Establish an ICME method to design HSLA steels
✓ Based on the existing HSLA100 steel
✓ Targeting comparable properties with the wrought steel

Current progress:
1. Established a high-throughput composition screening method
2. Three prototype steels have been developed
3. HSLA Powder manufactured and testing build is moving forward
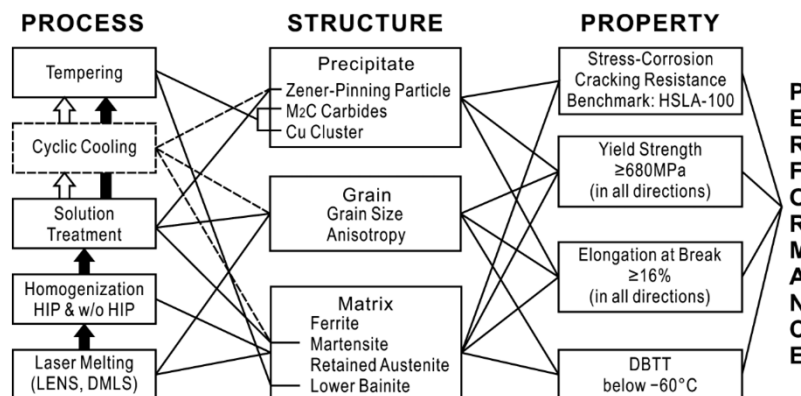
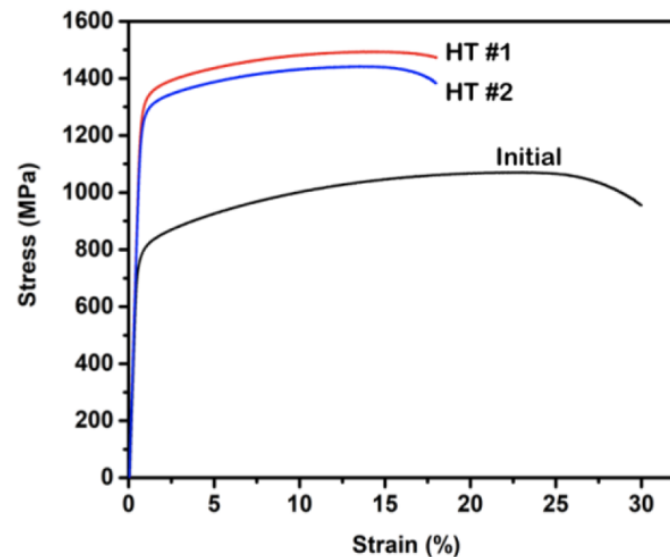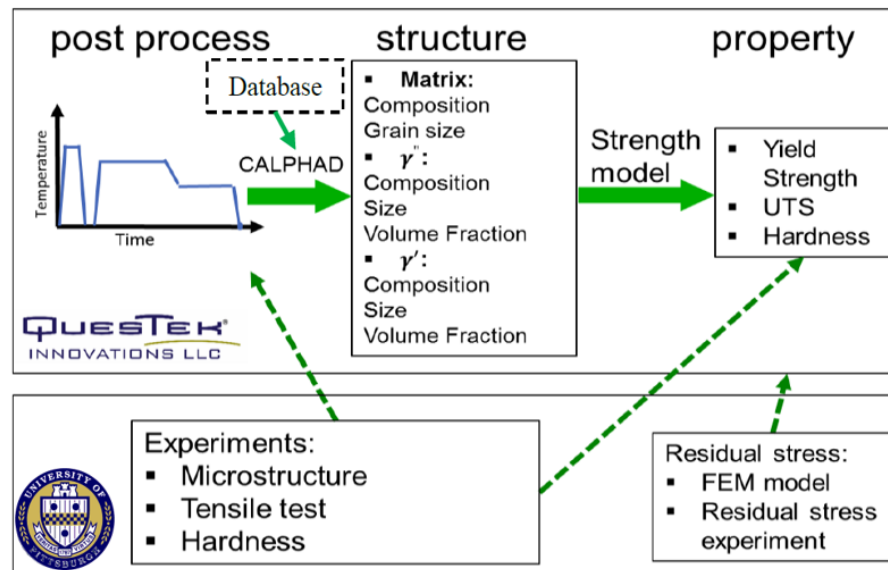# Post-heat treatment design for additive manufacturing

"Integrated Experimental and Analytical Technologies for Process Optimization and Qualification in Additive Manufacturing "
PI: Jiadong Gong (QuesTek); Co-PI: Wei Xiong & Albert To (Pitt)

   – Sponsor: NASA (STTR Phase II), Period of Performance: 11/1/2018-10/30/2020


- Develop the ICME framework for Inconel additive manufacturing processing optimization
- Generate a better standard for Inconel 718 manufacturing steps based on powder bed

Seed ideas for today's discussion

- Advanced materials design
  - New generation steels and superalloys
  - Complex concentrated alloys (e.g. HEA high entropy alloys)
- Advanced manufacturing
  - New stack materials design (e.g. additive manufacturing)
    - Composition optimization of the current alloys for advanced manufacturing
    - New composition design (for mechanical performance including corrosion)
  - In-situ monitoring to provide accurate feedback in manufacturing
  - Post heat treatment design (post-weld heat treatment)
- Simulation and modeling
  - Materials Genome (CALPHAD)
  - ICME (Integrated Computational Materials Engineering) approach
    - How to integrate Materials, Mechanical and Manufacturing?
  - Uncertainty quantification and scale-up for commercialization (**AI** techniques)
- Databases and standards
  - Both simulation and experiments
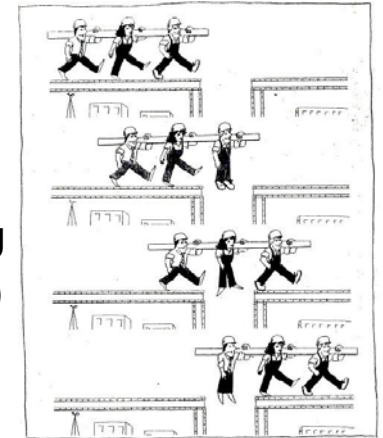
Wei Xiong, Gregory B. Olson, "Cybermaterials: Materials by Design and Accelerated Insertion of Materials", npj Computational Materials, nature publishing group, 2 (2016) 15009. https://doi.org/10.1038/npjcompumats.2015.9
Wei Xiong, Gregory B. Olson, "Integrated Computational Materials Design for High-Performance Alloys ", MRS Bulletin, 40 (2015) 1035-1043. https://doi.org/10.1557/mrs.2015.273