Manufacturing USA
Lightweight Metals Institute

Presentation to:
HPC4Mfg Industry Engagement Day

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Lightweight Innovations For Tomorrow Institute Mission

• Accelerate the development and application of innovative lightweight metal production and component manufacturing technologies to benefit the US transportation, aerospace and defense market sectors

• Deliver high value advanced alloy processing technologies that reduce the weight of machines that move people and goods on land, sea and air
LIFT Technology Scope

• Priority metal classes and their alloys:
  • Advanced High-Strength Steels, Titanium, Aluminum, and Magnesium

• Technology development grouped into six pillars:
  • Melt Processing
  • Powder Processing
  • Thermo-mechanical Processing
  • Low-cost Agile Tooling
  • Coatings
  • Joining and Assembly

• Coupled with cross-cutting themes:
  • Integrated Computational Materials Engineering (ICME)
  • Validation & Certification
  • Design
  • Life-cycle Analysis
  • Cost & Supply Chain Modeling
  • Corrosion
  • Blast & Ballistics
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LIFT TMP-R1-3b
Assured Properties in Al-Li Forgings

• Objective: Accurately predict the performance of aluminum-lithium alloys in formed parts by developing advanced computer simulations.

• Industry Partners:
  • United Technologies Research Center
  • Lockheed Martin

• Research Partners:
  • University of Michigan
  • Case Western Reserve University
  • The Ohio State University
  • Southwest Research Institute

Replace make and break with accurate computational simulations
High Performance Computing for Manufacturing Project

• Simulate the interaction and evolution of dislocations with the primary precipitates to predict the strength of proposed Al-Li alloys

• Includes full elastic interactions between dislocations, the evolution of dislocation networks, and the treatment of the precipitates as finite nanoscale objects locally interacting with the dislocations

• Execute large-scale dislocation dynamics simulations on supercomputing facilities at LLNL to investigate the parameter space of the precipitate microstructure to provide sufficient statistical information
Results & Benefits

• Development of new mobility law for Al and Al-Li alloys
• Large-scale simulations of aluminum with periodic arrays of ellipsoidal lithium (and other) precipitates show how to develop higher strength
• New lightweight high melting-point Al-Li alloys will allow us to reduce the weight of aircraft engine turbine blades
• Anticipated weight saving from these new blades is 20% - 25%
• Total weight saving per engine is about 75 lbs
• Total amount of fuel saving 13.5 million gallons per year
• Expected savings are $26M per year