
# The HPC4Mfg Program

**Lawrence Livermore National Laboratory, Lead**
**Sept 2015 - Present**

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HPC User Forum
Milwaukee, WI
September 6, 2017

# The HPC4Mfg program is designed to bring the many benefits of high-performance computing benefits brings many benefits to US Industry

- Accelerate innovation
- Lower energy costs
- Reduce testing cycles
- Reduce waste/reduce rejected parts
- Quality processes and Pre-qualify
- Optimize design
- Shorten the time to market

# The HPC4Mfg program lowers the barriers to bringing the power of HPC to the manufacturing community

- **Industry Status**:
  - Some larger companies use HPC, but struggle to stay current
  - Few small to medium companies use HPC
- **DOE Status**:
  - DOE labs possess 5 of the top 10 HPC systems worldwide; 2 of top 4 in Graph500
  - Broad expertise in the application HPC
  - Can be a challenge for industry to understand the best way to partner with DOE


***HPC4Mfg creates partnerships that leverage DOE lab expertise and compute resources to address critical problems in the manufacturing sector***

# The HPC4Mfg program is building an ecosystem to support HPC adoption by industry

- Showing what is possible with HPC through demonstration projects
  - AMO funds < $300k to laboratories
  - Industry funds at least 20% in-kind support w/ optional cash contribution
  - Project duration < 1 year

- Encouraging the adoption of HPC through capability projects
  - Execution mechanisms and funding source varies
  - Project duration: multiple year
- Building the HPC Manufacturing community
  - Industry Engagement Day
  - Student intern programs

# Our unique approach to building teams helps ensure each project's success

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FEDBIZOPPS.GOV Federal Business Opportunities

**Engage industry**

Industry submits challenges

**Match challenge to PI**

AMO approval; Feedback to industry

Sign agreements

**Inform industry**

Concept paper → Full proposal → Award

Technical Review Committee

**Technical Merit Review Committee**

- Partner labs and AMO representatives
- Heavy focus on **nation-wide** impact to energy efficiency and clean energy technology industry-wide

Execution streamlined through the required use of the DOE short form

# Status: The HPC4Mfg Program is growing…

**March – September 2015**

Launch program with seedling projects

- LLNL established the program
- $1.5M: 5 seedling projects
- Industry outreach

**September 2015–March 2016**

Inaugural solicitation

- LBNL, ORNL join as partner labs
- $3M solicitation: 10 demonstration projects to 8 companies

**March 2016 -**

Steady state

- Solicitation twice a year (typically $3M each)
- Summer internships
- Implementation/Development projects
- Added participating laboratories: ANL, NREL, NETL
- Added new focus area of materials in severe environments

- *Compute resources from across the DOE complex*
- *Launched annual Industry Day*
- *Student internship programs*

# The HPC4Mfg program has a diverse portfolio

- $>13M technical portfolio
  - Executing on 41 projects with 33 industry partners and 6 labs
  - 40 demonstration; 1 capability
  - Seedling project funded by Office of Transportation
- Spring 2017 Solicitation
  - $3M available
  - New area of materials in severe environments
  - Other DOE offices informally involved
  - 57 Concept papers submitted; 26 moving forward to full proposals

# The concept paper participation has been diverse in both geographic location and topic

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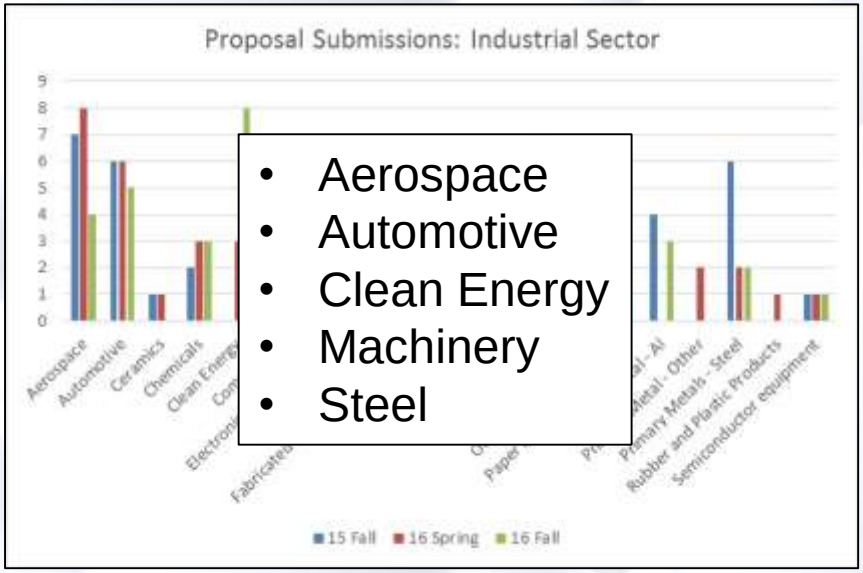
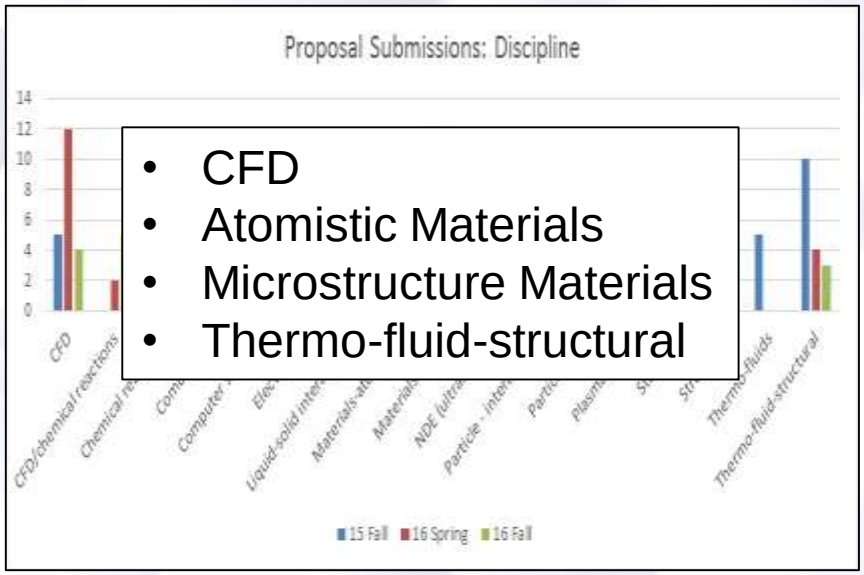



- Aerospace
- Automotive
- Clean Energy
- Machinery
- Steel


- Additive Manufacturing
- Casting
- Chemicals
- Metal Refining
- Semi-conductor Fabrication




- CFD
- Atomistic Materials
- Microstructure Materials
- Thermo-fluid-structural

# HPC4Mfg is extending our scientific knowledge in different industrial sectors

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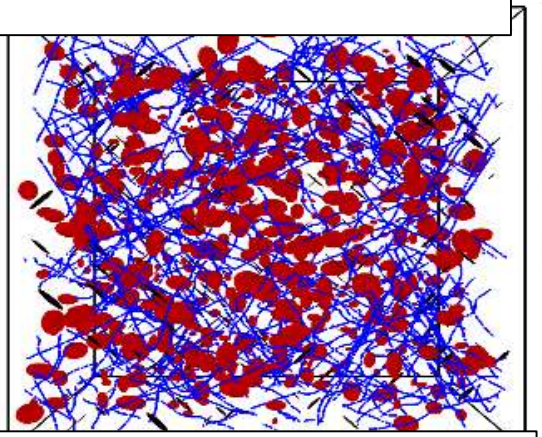
## Creating new lightweight alloys

**Goal**: Predict the strength of lightweight aluminum-lithium alloys produced under different process conditions; could save millions of fuel costs if used in aircraft design

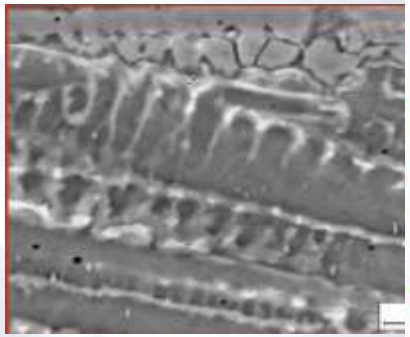


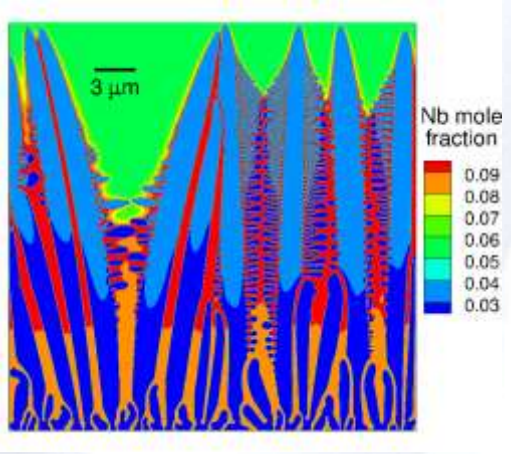
**Results to date**: Developed new dislocation mobility laws for Al-Li alloys; examining influence of different precipitate density; predicting yield strength for differing particle sizes

**Team**: LIFT with LLNL and Univ Mich.

## Dendritic Growth in AM Parts

**Goal**: Use HPC to model multi-scale morphology of solidification microstructure of Nickel base 718






**Results to date**: Predicting crystal growth over large domains from multi-component alloys using phase field approaches; moving to new alloy systems and 3D

**Team**: UTRC with ORNL/LLNL

# HPC4Mfg is improving industrial workflows and speeding up modeling time using HPC

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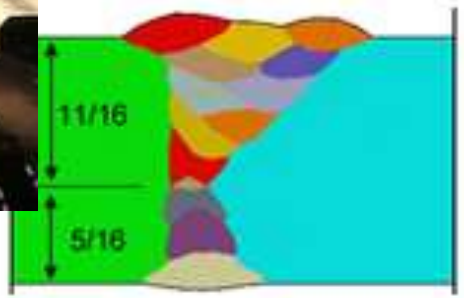
## Weld Predictor Tool

**Goal**: Develop an improved online welding software modeling application using advanced 3D models, more material hardening laws, and open source parallel codes




Images courtesy of EWI

**Results to date**: Developed new front end interface and automated meshing tools; working on new parallel simulation tools for thermal analysis, microstructure prediction, and mechanical analysis

**Team**: Edison Welding Institute with ORNL/OSU

## Paper Towel Design

**Goal**: Use HPC to evaluate different microfiber configurations to optimize drying time while maintaining user experience

**Results to date**: New mesh tool reduces product design cycle by 2X cycle; additional cores by another 8X; largest non benchmark run of Paradyn code at LLNL

**Team**: Procter and Gamble with LLNL

# HPC4Mfg is improving manufacturing operation in energy–intensive environments

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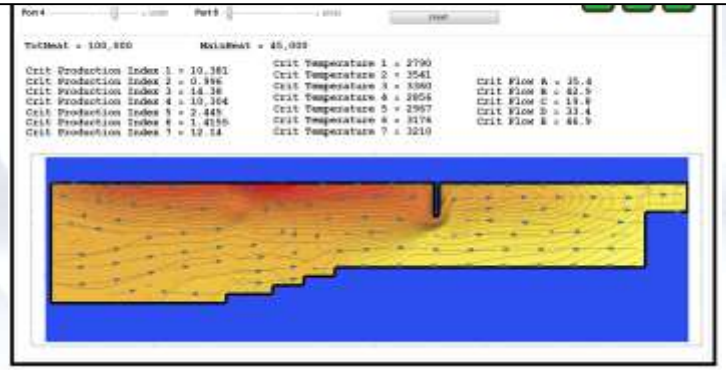
## Glass Making Operation

**Goal**: Optimize process operation and production of glass making using HPC; save 2 weeks of production per year per furnace; save 2.5 TBTUs of energy and avoid 130,000 metric tones on carbon dioxide emissions

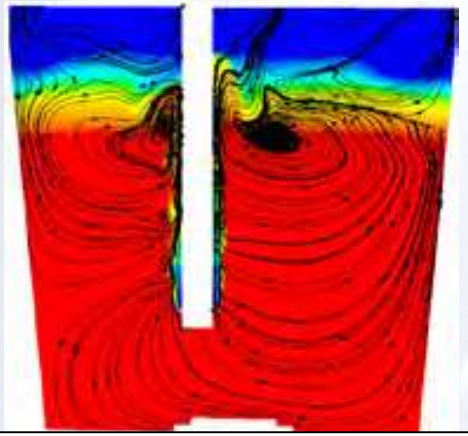


**Results to date**: Fully validated fluid model used for a parameterization study; statistical analysis and machine learning to create a reduced order glass furnace model for real time process adjustments

**Team**: Vitro Glass with LLNL

## Blast Furnace Operation

**Goal**: Optimize blast furnace operation to reduce coal coke usage, energy consumption



**Results to date**: Parallelized blast furnace code is 100X faster than previous code; studies conducted to evaluate coke usage as a function of operational parameters

**Team**: US Steel with Purdue and LLNL

# HPC4Mfg is leading to significant energy savings in new products or processes

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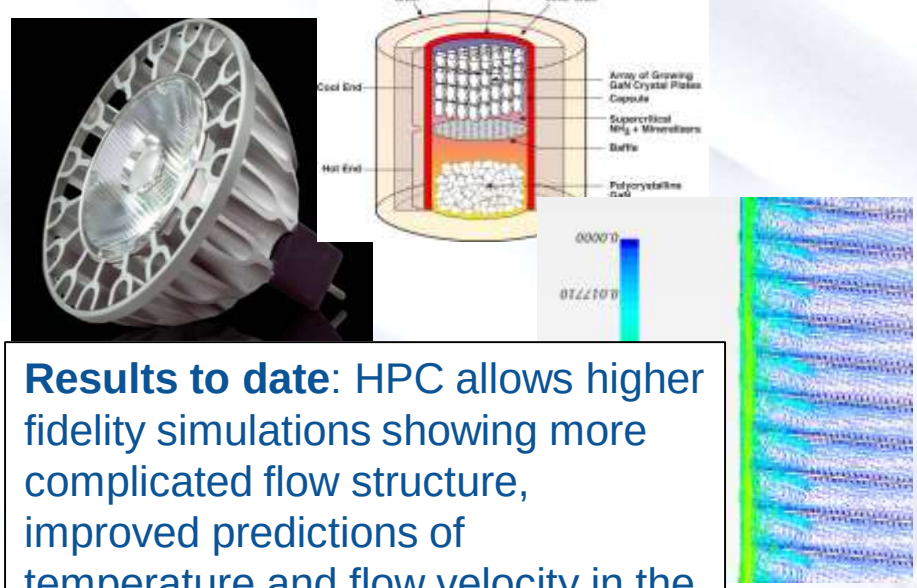
## More efficient LED lightbulb

**Goal**: Model ammono-thermal crystal growth of GaN to scale up the process; reduce production costs of LED lighting by 20%

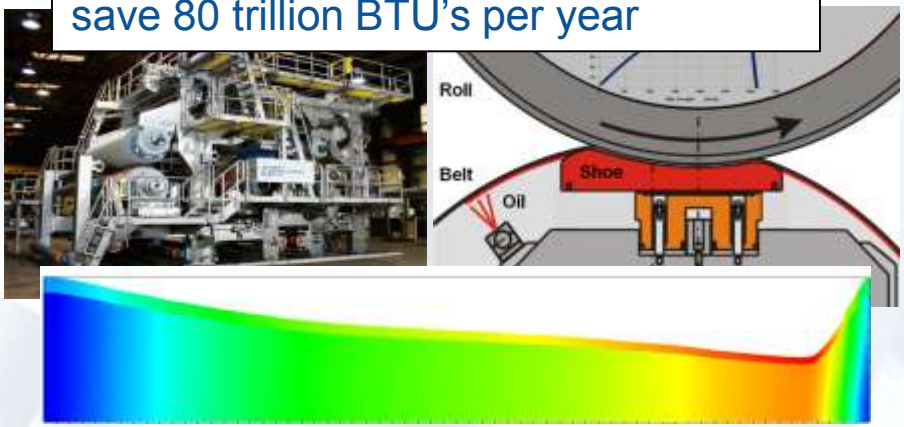



**Results to date**: HPC allows higher fidelity simulations showing more complicated flow structure, improved predictions of temperature and flow velocity in the reactor; now optimizing uniform growth of crystals

**Team**: SORAA with LLNL

## Energy savings in paper making

**Goal**: Use multi-physics models to reduce paper rewetting in the pressing process; reduce 3rd most intense energy consumer in paper making; save 80 trillion BTU's per year



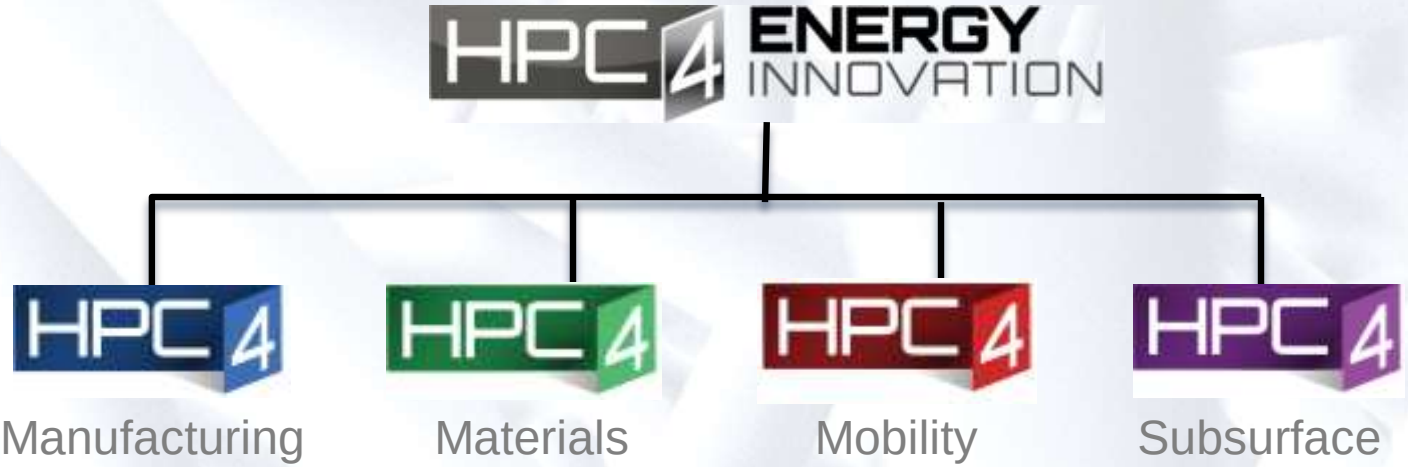

**Results to date**: Using both continuum and pore-scale approaches to determine how water flows through porous paper pulp; simulations can be used to optimize drying

**Team**: Agenda2020 with LBNL/LLNL

# If HPC4Mfg is successful…

- The development and deployment of energy-efficient manufacturing is accelerated through funded projects
- The production or adoption of clean tech is enabled through funded projects
- HPC becomes a useful tool to a broad array of small, medium, and large companies in designing new products, reducing cost and energy consumption, accelerating time to market
- More collaborations between DOE labs and U.S. manufacturers are enabled increasing competitiveness
- Simulation capabilities at the DOE laboratories are improved

# The HPC4Mfg Program was designed to be scaled to other focus areas




AMO sponsor, working with Jeff Roberts and others, is planning a significant increase and expansion in next 4 years

# The HPC4Mtls program

- The purpose of the HPC4Mtls program will be to advance the design, performance, and understanding of in-service materials in severe environments.

- **Severe Environments**: Environments that will degrade and cause to fail widely available materials faster than is desired and for which alternatives are either prohibitively expensive or not available.

- Lead labs are : LANL, LLNL, ORNL, NETL
- Language included in 4th solicitation of HPC4Mfg on this topic
- RFI and notice of intent released soon; workshop in October
- Hoping to have a full solicitation in the fall under the HPC4Mfg/EnergyInnovation umbrella in January

# Questions?

**Additional information at HPC4Mfg.org**

**Questions can be sent to**
**HPC4Mfg@llnl.gov**

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***Session later this afternoon will highlight two projects from this program***