

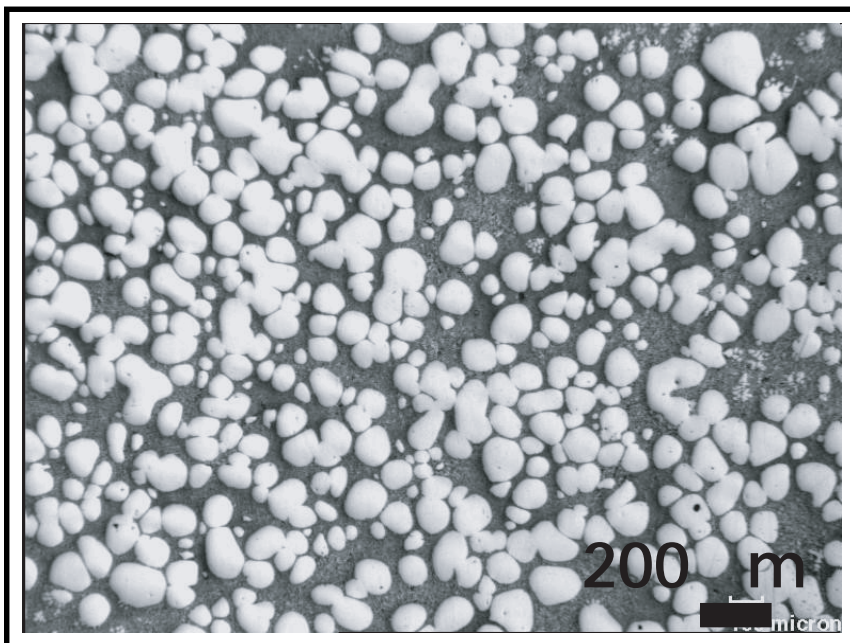
# Industrial Technologies Program

## Innovative Semi-Solid Metal (SSM) Processing

Semi-solid metals can be widely used to produce aerospace, automotive, marine, and light and heavy equipment components. However, the current state of the art production of SSM feedstock, either in practice or under development, is based on the MHD and the slurry-on-demand approaches. These approaches require additional processing and melting steps in order to produce either rheocast feedstock billets (MDH) for shipment or SSM slurries (slurry on demand) in house. These avoidable processing steps consume more energy yet they yield inconsistent results.

Researchers at Worcester Polytechnic Institute have investigated more economical and consistent SSM production technologies that reduce unnecessary processing steps. These

researchers have discovered significant promise in the Continuous Rheoconversion Process (CRP) approach. CRP has the potential to considerably reduce process costs and energy consumption by directly producing the desirable SSM microstructure. The proposed project will serve as a building block to the development of optimum alloys and optimum heat treatment schedules that are specifically designed for the SSM/CRP process.



Typical CRP slurry microstructure of an A356 alloy (no grain refinement) at 585°C. The average Alpha particle size is 86  $\mu\text{m}$ .



### Benefits for Our Industry and Our Nation

- Optimum heat treatment schedules that are specifically designed for the Continuous Rheocasting Process.
- The ability to produce highly globular, desirable semi-solid metal microstructures.

### Applications in Our Nation's Industry

*This research will develop the Continuous Rheocasting Process (CRP) for producing low-cost Semi-solid Metal (SSM) which could lead to dramatic increase of market share in casting produced by SSM.*

## Project Description

The goal of this project is to develop an energy efficient alternative (CRP) to semi-solid metal production routes that are currently in practice or under development.

The objectives of this research are:

- Optimize the CRP.
- Develop optimum alloys that are specifically designed for the SSM/CRP process.
- Develop optimum heat treatment schedules that are specifically designed for the SSM/CRP process.
- Develop a comprehensive constitutive mathematical model that includes the internal microstructural dynamics of SSM slurries and allows better simulation of die filling during the production of SSM parts.
- Provide means for commercializing the CRP through collaboration with the 40+ member companies of the ACRC.
- Involve graduate and undergraduate students in the research to further their education of solidification science and technology and their awareness of energy needs and costs.

## Milestones

The tasks for this project are:

1. Optimize CRP for commercial applications: Model, design and manufacture an optimum chiller, and conduct SSM stock production experiments and evaluate SSM feedstock quality to optimize CRP.
2. Develop and standardize rheology measurements: Study constant shear conditions, step change shear and sweeping change shear and identify key parameters to standardize experiments.
3. Develop optimized alloys for SSM: Develop optimized alloys for SSM through thermodynamic modeling, rheological studies, microstructure analysis and mechanical property testing.
4. Optimize heat treatment for SSM: Optimize heat treatment for SSM through heat treat modeling, microstructure analysis and mechanical property testing.
5. Conduct computational and modeling studies: Characterize the rheological behavior of slurries, study the effect of wall slip on mold filling dynamics and develop and verify a comprehensive model.

## Project Partners

*Worcester Polytechnic Institute*  
Worcester, MA

*North American Die Casting Association*, Wheeling, IL

*Cast Metals Coalition Partnership*  
Charleston, SC

*AMCAST*  
Southfield, MI

*SPX Contech*  
Portage, MI

*THT Presses*  
Dayton, OH

## A Strong Energy Portfolio for a Strong America

Energy efficiency and clean, renewable energy will mean a stronger economy, a cleaner environment, and greater energy independence for America. Working with a wide array of state, community, industry, and university partners, the U.S. Department of Energy's Office of Energy Efficiency and Renewable Energy invests in a diverse portfolio of energy technologies.



U.S. Department of Energy  
Energy Efficiency  
and Renewable Energy

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