
Improved Energy Efficiency and Cost Efficiency through Non-Thermal, High Magnetic Field Processing

Conventional heat-treating is the most common process used by industry to achieve desired metallurgical properties such as strength and toughness, but it is energy-intensive—and therefore expensive—to perform. The development of more cost-effective, energy-efficient processing methods would increase industry’s energy productivity and its competitiveness.

A partnership between government and industry researchers intends to address this challenge by developing a heat-free processing technology involving high magnetic field processing (HMFP). This innovative, non-thermal materials processing technology has the potential to minimize or even eliminate traditional energy-intensive processing steps by employing superconducting magnets to apply high magnetic fields to manipulate materials structure at an atomistic level. The ability to tailor structure at the micro- and nanoscale could enhance material performance with significantly reduced energy and processing costs.

Benefits for Our Industry and Our Nation

The use of HMFP in industrial materials processing will provide an energy-efficient, cost-effective method to improve materials performance in applications such as bar/rod normalization, spheroidization heat treatments, and casting.

These applications represent a small example of HMFP’s transformational and cross-cutting potential.

Applications in Our Nation’s Industry

Heat-treating materials has been the conventional method for industry to obtain desired metallurgical properties. HMFP would provide an energy-efficient alternative to the vast industrial treatment needs of both the primary market (e.g., forging, casting, rod and bar, and sheet metal products) and the secondary market, which produces specific components (e.g., bearings, axles, and wires).

Project Description

The main goal of this project is to research and develop HMFP technology for selected high-energy-consumption heat treatment operations by reducing or eliminating the need for cryogenic cooling or double temper heat treatments. Another project goal is the demonstration of an electromagnetic acoustic transducer (EMAT) process, for casting of ferrous alloys under HMFP, to improve microstructural homogeneity and properties over conventionally-cast products.

Barriers

- Identification of currently energy-intensive, high-temperature processes that would benefit most from HMFP technology
- Adequate definition of the design characteristics of a commercially viable prototype at an economically viable cost

Pathways

Industry participants will identify applications for first commercial demonstration. Researchers will experiment with HMFP to develop enhanced microstructures and properties for the intended application. Completion of these experiments will lead to analysis and characterization of the properties of the resulting candidate alloys. Project participants will also develop the design requirements for an HMFP system to facilitate commercialization by demonstrating the non-contact EMAT process for casting of ferrous alloys.
Milestones
This 3-year project started in August 2008 and includes the following milestones:

• Conduct experimental test plans on test coupons for one specific application to determine and address the application’s specific needs (Completed)

• Conduct experimental test plans on test coupons for additional applications

• Define thermomagnetic processing system design for at least one application with partners

• Hardware scale-up of magnetic processing system (Complete)

• Commercialization and technology transfer

Commercialization
HMFP technology is a potentially transformational, cross-cutting, and enabling technology that could revolutionize the energy requirements and performance of U.S. metals processing. American Magnetics Inc., a leading superconducting magnet manufacturer, will serve as the magnet designer and producer. Ajax TOCCO, a major induction heating system manufacturer, will be the primary equipment supplier. Carpenter Technology, Caterpillar, Inc. and Durabar are end users who are evaluating HMFP technology to meet their corporate energy efficiency and product performance goals.

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