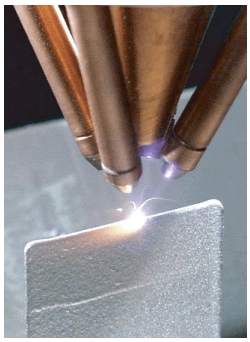
Industrial Technologies Program

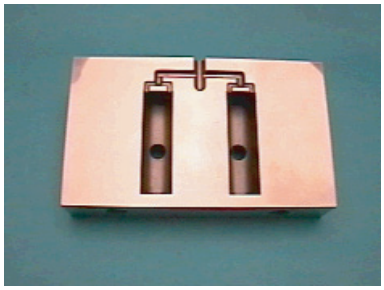
The Use of Laser Engineered Net Shaping for Rapid Manufacturing of Dies with Protective Coatings and Improved Thermal Management

Most dies in the casting industry are machined from premium grade H-13 tool steel. While these dies provide excellent performance in terms of service life, they have some inherent limitations. First, the machining methods are not capable of producing irregularly shaped cooling channels for reduced cycle times. Second, localized deposition of high thermal conductivity materials (e.g., copper) for further improvement to thermal management is not possible. Finally, the conventional die fabrication route is rather slow and thus increases the time between product design and full-scale production.

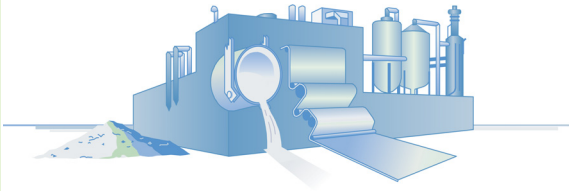
Ohio State Researchers are developing the use of Laser Engineered Net Shaping (LENS), a relatively new solid freeform fabrication process that is capable of rapidly producing complex, dense parts directly from a computer aided drawing without the need for molds or ancillary tooling. In addition, the process can produce parts with localized variation in composition. With this unique process, it becomes possible to rapidly fabricate dies with complex cooling channels and localized variation in composition for improved thermal management.



Photograph of LENS process in operation. A laser is used to melt a thin surface layer of material, and powder is injected into the molten pool through four copper nozzles in order to make components in a layer-by-layer fashion.



Photograph of a die made with conformal cooling using the LENS process.



Benefits for Our Industry and Our Nation

- *Fabrication of dies with complex cooling channels is done more rapidly.*
- *Improved thermal management.*
- *Reduction in lead time.*

Applications in Our Nation's Industry

This unique LENS process will enable die casters to rapidly fabricate dies with complex cooling channels and localized variation in composition for improved thermal management.

Project Description

The goal of this project is to use laser engineered net shaping to rapidly manufacture dies with protective coatings, and by doing this, improve thermal management.

The specific objectives are:

- Develop and apply design rules for dies with complex cooling channels and localized composition variation
- Establish the capabilities of the LENS process in terms of potential die configurations and materials
- Determine the expected life of dies fabricated with the LENS process and, if needed, optimize the alloy and/or process for improved die life.

Milestones

The milestones for this project and the point within the project they will take place are:

1. Fabrication of LENS dies
2. Comparison of cycle times
3. Development of design rules
4. Fabrication of samples for service life evaluation
5. Microstructural and Mechanical property characterization

Project Partners

Ohio State University
Columbus, OH

North American Die Casting Association, Wheeling, IL

Cast Metals Coalition Partnership
Charleston, SC

AMCAN
Burlington, Ontario

Exco Engineering
Newmarket, Ontario

Ried & Assoc.
Portage, MI

Ryobi Die Casting, Inc.
Shelbyville, IN

Walkington Engineering, Inc.
Cottage Grove, WI

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
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