

METALCASTING

Project Fact Sheet



CERAMIC COMPOSITE DIE FOR METALCASTING

BENEFITS

- Potential for significant energy savings through reduced materials consumption and more efficient use of dies
- 2 to 5 times harder than tool steels, resulting in 5 to 10 times longer useful life at a lower unit cost, with less than half the weight
- Proven stability when exposed to molten metals
- Offers resistance to corrosion, erosion, oxidation, thermal fatigue, and cracking
- Lowers unit production costs due to fewer rejected castings and less waste of failed casting dies

APPLICATIONS

Materials and Electrochemical Research (MER) Corporation is drawing on its substantial experience with ceramic composites to develop a material capable of delivering stronger, more stable dies for metalcasting operations. This new ceramic composite die for metalcasting could serve as a substitute for steel used in die casting, particularly for casting aluminum.

NEW CERAMIC COMPOSITE MATERIALS TO PRODUCE SUPERIOR, LOW COST DIE CASTING MATERIAL

Metalcasting, a major U.S. industry, has long been hampered by the high cost and short life of casting dies. Steel dies often fail prematurely due to metal-fatigue cracking, corrosion, erosion, oxidation, heat checking, and soldering when the dies are exposed to molten metals while operating under cyclic-mechanical and thermal loading. These deficiencies have contributed, in part, to the many casting-industry jobs that have moved overseas in the last 10 to 15 years.

For some applications, coatings are applied to protect the die from the damage inflicted by molten metals. However, these coatings can fail prematurely, and they tend to interfere with the welding and polishing operations needed during reworking and correcting damages in the die.

Ceramic composite materials offer a promising alternative to conventional technologies used in casting dies. Ceramic composites can deliver proven stability to molten metals and are resistant to corrosion, erosion, oxidation, thermal fatigue, and cracking. In addition, lower cost hybrid composites in the nitride/nitride-carbide family have the potential to last 10 times longer than coated steel dies at approximately 50 percent of the weight. These new composites are expected to reduce the cost of many products fabricated in the United States and create stronger competitiveness in the domestic metalcasting industry.

CERAMIC COMPOSITE DIE FOR METALCASTING



PIX#09183 Photo courtesy of MER Corporation

Materials and Electrochemical Research Corporation develops long-lasting, competitively priced ceramic composite components for use in the metalcasting industry.



Project Description

Goal: Develop and test a ceramic composite die in industrial die-casting operations.

When used in casting dies, tool steels such as H13, D2, and M2 can fail prematurely from thermal fatigue and cracking, often accompanied by residual tensile stresses, die-surface corrosion, or metal oxidation, all which are accelerated by high temperatures and cycling of the die. Coatings are often applied to protect the die, with performance determined by the number of castings that can occur before degradation begins. For example, hard chrome offers a performance of about 5,000 to 10,000 casts, while titanium-nitride composites applied through plasma-assist chemical vapor deposition offer approximately 80,000 casts or more before degradation. Because the plasma-assist chemical vapor deposition process is not available domestically, the metalcasting industry is faced with a dilemma: omit the coating and significantly reduce the die's useful life or add the coating, but also add cost and complicate repair and refurbishing.

A new ceramic composite technology addresses this dilemma with a ceramic-composite die featuring a unique nitride/nitride-carbide matrix, which outlasts other materials and requires fewer repairs. The Materials and Electrochemical Research (MER) Corporation has years of experience developing and marketing other ceramic composites based on similar technology. The challenge now is for the company to fabricate and test under industry operating conditions a composite capable of demonstrating the stability and low cost of this new technology for die-casting operations.

MER Corporation is developing this new technology with the help of a grant funded by the Inventions and Innovation Program in the Department of Energy's Office of Industrial Technologies.

Progress and Milestones

- Results of previous, similar work by the developer indicate high probability of success in achieving the project goal and commercializing the technology.
- Initial contacts with major large-scale die companies have been encouraging.
- Initial focus will be on creating various fiber-reinforced composites, followed by property-characterization tests, especially in molten-aluminum immersion conditions.
- Selected test die will be fabricated and evaluated internally, with subsequent testing completed by a commercial die company.

Economics and Commercial Potential

Confronted with the ongoing use of expensive, short-lived casting dies, the metalcasting industry is eager to see the development of alternative die-casting technologies. The ceramic composite die for metalcasting represents such an alternative, with the promise of half the weight of conventional steel dies and 10 times the useful life. Commercial success of the ceramic composite die will depend on its performance and cost effectiveness relative to coated steel dies. If overall performance is proven to be as high as expected, the new die will perform at least 5 to 10 times better than conventional steel dies, while being fabricated at approximately the same cost. These demonstrated cost and performance features will be key competitive advantages in the current marketplace.

INDUSTRY OF THE FUTURE—METALCASTING

The metalcasting industry – represented by the American Foundrymen's Society (AFS), North American Die Casting Association (NADCA), and the Steel Foundry's Society of America (SFSA), has prepared a document, "Beyond 2000," to define the industry's vision for the year 2020. OIT's Metalcasting Vision Team partners with metalcasters, national laboratories, universities, and trade/environmental/technical organizations to develop and implement energy efficiency technologies that benefit both the industry and the United States. Recently, the Metalcasting Team facilitated the development of the Metalcasting Technology Roadmap, which outlines industry's near-, mid-, and long-term R&D goals.

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The Inventions and Innovation Program works with inventors of energy-related technologies to establish technical performance and conduct early development. Ideas that have significant energy savings impact and market potential are chosen for financial assistance through a competitive solicitation process. Technical guidance and commercialization support are also extended to successful applicants.

PROJECT PARTNERS

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