



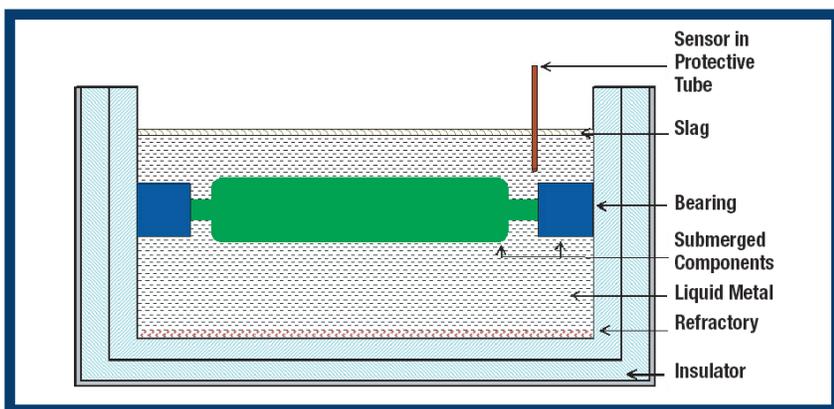
## INDUSTRIAL TECHNOLOGIES PROGRAM

# Multifunctional Metallic and Refractory Materials for Energy-Efficient Handling of Molten Metals

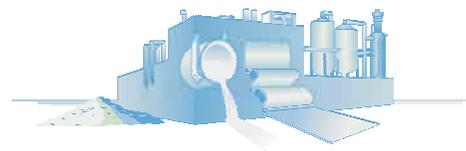
## Improved Materials Will Extend Life of Hardware and Increase Efficiency by Reducing Thermal Losses

Liquid-metal containment and submerged hardware (used for melting, recycling, and transfer processes in the aluminum, steel, and metal casting industries) in contact with molten metal and slag are subject to significant corrosion and wear. Corrosion and wear result in contamination of the melt and loss of product quality. For example, submerged hardware used for steel-galvanizing types of processes undergo liquid metal corrosion and require replacement in one to three weeks, leading to significant loss of energy from downtime and diminished product quality due to the change-over process. Failure of wall refractory materials leads to energy losses through the walls, with eventual attack of the container walls.

This project will focus on reducing liquid-metal corrosion of refractories and submerged hardware along with improvements in thermal management of liquid metal systems through the development of new materials. The understanding of failure mechanisms combined with thermodynamic modeling will lead to the development of new metallic alloys and coatings with better resistance to attack by molten aluminum and aluminum alloys. Refractories with better wear resistance and more desired thermal characteristics will also be developed to minimize attack of container walls. The knowledge base acquired in this project will also be applicable to the development of new materials resistant to attack by molten steels.



*Improved materials in contact with molten metals would enable extended life, improved thermal efficiency, and decreased downtime.*



### Benefits for Our Industry and Our Nation

The advanced materials systems that will be used for molten metal containment and handling will result in increased energy efficiency, reduction of downtime and yield loss, improvement in overall product quality, reduced repair and replacement cost of corroded components, reduced environmental impact, and improved economics.

### Applications in Our Nation's Industry

The new and improved molten metal containment materials will find applications in various industries that are involved with the containment or handling of liquid metals including aluminum, steel, and metal casting.

## Project Description

The goal of the project is to extend molten-metal containment and submerged hardware life by an order of magnitude and improve the thermal efficiency of molten metal containment.

## Barriers

Major barriers to be overcome include:

- Lack of knowledge of the mechanisms by which failure occurs in various types of hardware;
- Lack of a generalized dynamic corrosion model to predict wear and failure of hardware applicable for molten materials handling applications; and
- Lack of a systematic approach to the design of new materials based on improved understanding of mechanisms.

## Pathways

The objectives of the project will be achieved through (1) understanding damage (failure) mechanisms in materials currently used; (2) designing new materials with hardened surfaces, corrosion-resistant phases, reduced grain boundary or binding phase, or with anti-wetting agents, as appropriate; (3) testing the new multifunctional materials in the laboratory and in plant trials; (4) performing lifetime prediction analyses using data from laboratory and in-plant tests; and (5) recommending materials for final industrial implementation.

## Milestones

- Complete industrial survey and failure analyses of components removed from service
- Complete laboratory testing of current materials
- Complete dynamic corrosion modeling and compilation of materials corrosion database
- Complete ThermoCalc™ analysis of metallic and refractory systems
- Identify metallic materials, coatings, and/or surface treatments for submerged hardware for molten metal bath applications
- Identify materials, coatings, and/or surface treatments for refractory linings
- Complete static corrosion testing, wear testing, and lab-scale dynamic testing
- Complete production in-line testing of bulk materials, surface treatment, and coating for both metallic and refractory materials
- Complete fabrication and testing of components

## Commercialization

This project will be conducted by a team consisting of steel, aluminum, metal casting, and refractory partners, as well as hardware suppliers and research organizations. The team approach will lead to implementation of the new materials technologies. The materials suppliers and equipment manufacturers on the team will be able to market the new technologies to other project partners and in the open market.

## Project Partners

West Virginia University  
Morgantown, WV  
(Ever Barbero; ebarbero@wvu.edu)

Allen Engineering  
Allied Minerals  
AK Steel  
Blasch  
Corhart Refractories  
Deloro Stellite  
Duraloy Technologies  
Emhart Glass  
Energy Industries of Ohio  
International Lead Zinc Research Organization  
Industries of the Future- West Virginia  
Magneco/Metrel  
Metallics Systems  
Monofrax Refractory  
R. E. Moore and Associates  
MORCO Refractory  
Oak Ridge National Laboratory  
Pechiney Rolled Products  
Praxair Technologies  
Secat Inc.  
Special Metals  
Sturm Rapid Response Center  
Thermal Ceramics  
Unifrax  
University of Missouri-Rolla  
Vesuvius McDanel  
Weirton Steel  
West Virginia Steel Futures Inc.

## 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.

For more information contact:

EERE Information Center  
1-877-EERE-INF (1-877-337-3463)  
[www.eere.energy.gov](http://www.eere.energy.gov)



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CPS #16943.

June 2004