

EXECUTIVE SUMMARY

Containment of liquid metals during melting, recycling, and transfer processes in the aluminum, steel, and metal casting industries can lead to significant corrosion and wear or abrasion of the refractories in contact with the molten metal and slag. The corrosion and wear of the refractories result in contamination of the melt [1] and failure of the refractory with energy loss through the containment walls and eventual attack of the container walls. In the finishing operations of steel, it is dipped in molten baths of zinc (galvanizing), Zn-5% Al (Galfan®), Zn-55% Al (Galvalume®), and Al-8% Si (alumize coating) for corrosion protection. The coating bath temperatures increase with the aluminum content and range from 440°C for zinc to 680 °C for alumize coating. The submerged hardware (sink and stabilizing rolls) is used in molten metal baths of the above materials for proper dipping of steel and control of the coating thickness. All of the molten metal baths used for coating aggressively attacks the submerged hardware. The severity of the attack increases with increasing aluminum content of the bath and the bath temperature. The submerged hardware requires its replacement in one to three weeks with significant loss of energy from down time and product quality during the change over process.

Reduction of liquid-metal corrosion of refractories and submerged hardware and improvements in thermal management of liquid metal containers would allow (1) energy savings, (2) reduction of downtime and yield loss (3) improvements in overall product quality, (4) reduced repair and replacement costs of corroded components, (5) reduced environmental impact, and (6) improved economics.

Industries that would benefit from the outcome of this project include those that involve the containment or handling of liquid metal. The key sectors include steel companies with hot-dipping lines; aluminum companies and metal casting companies. Other industries which would also benefit from the approaches in this project are: glass producers, pulp and paper producers, chemical producers, refractory producers, petroleum refiners, permanent-mold continuous die casting companies, and renewable energy systems manufacturers.

The research objectives of this project are to develop multifunctional metallic and refractory materials and surface treatment, coatings and claddings for life improvement of molten metal containment and submerged hardware and improved thermal management in aluminum, steel, and metal casting industries. The project goal is to extend the molten metal containment and submerged hardware life by an order of magnitude and improve thermal efficiency with energy savings of 333 trillion BTU/year and cost savings of approximately \$1 billion/year by 2020.