Development of Cost-Effective Low-Permeability Ceramic and Refractory Components for Aluminum Melting and Casting

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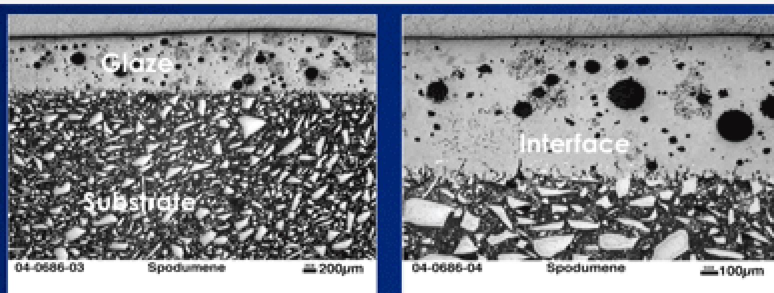
Goals and Objectives:

- Develop and validate new classes of cost-effective low-permeability ceramic and refractory components for handling molten aluminum in both smelting and casting environments.
- Develop materials and methods for sealing surface porosity in thermal shock-resistant ceramic refractories, which will also include the evaluation of monolithics used in the low-pressure casting of aluminum.

Benefits:

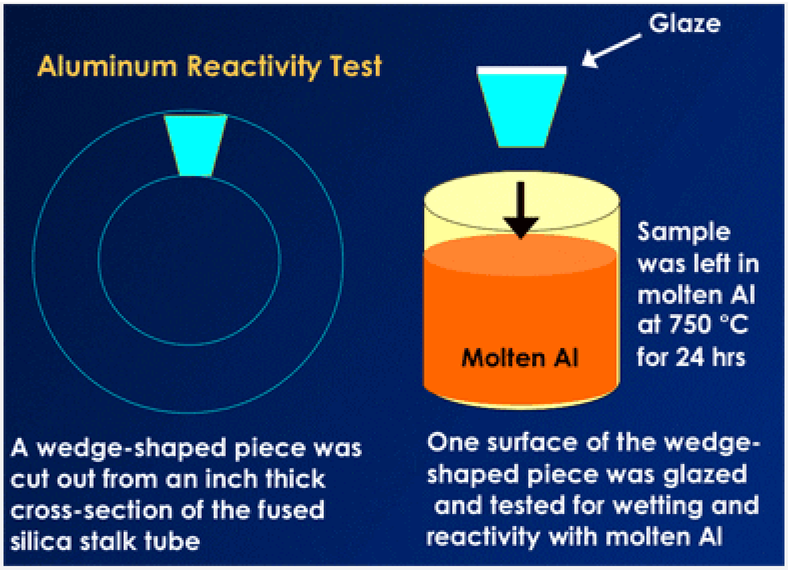
Enhancement of the pressure-holding capacity of fused silica tubes and their implementation in aluminum melting and casting will accomplish the following:
Reduced downtime through longer life and reduction in scrap through lower rates of erosion and particulate generation
Reduction in the overall energy use by improving casting operations (energy savings of 30 trillion Btu/year by 2020)

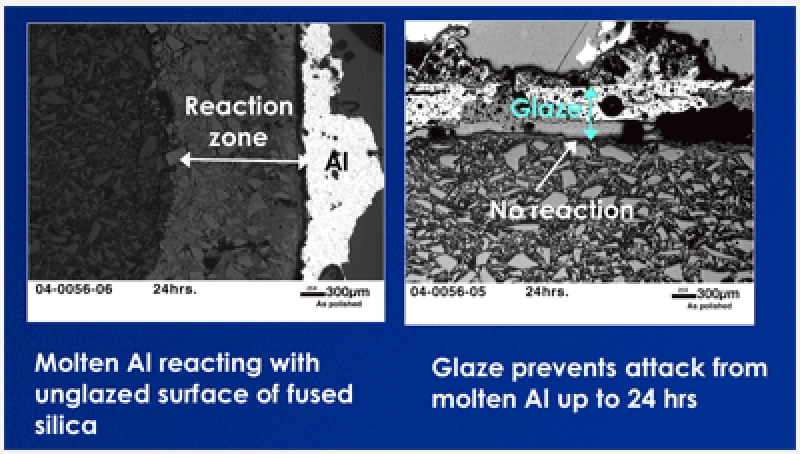
Semi-Crystaline Glazes:

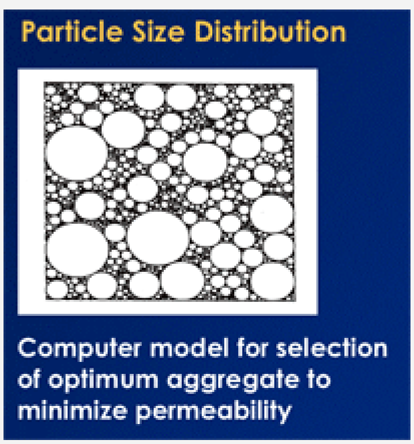


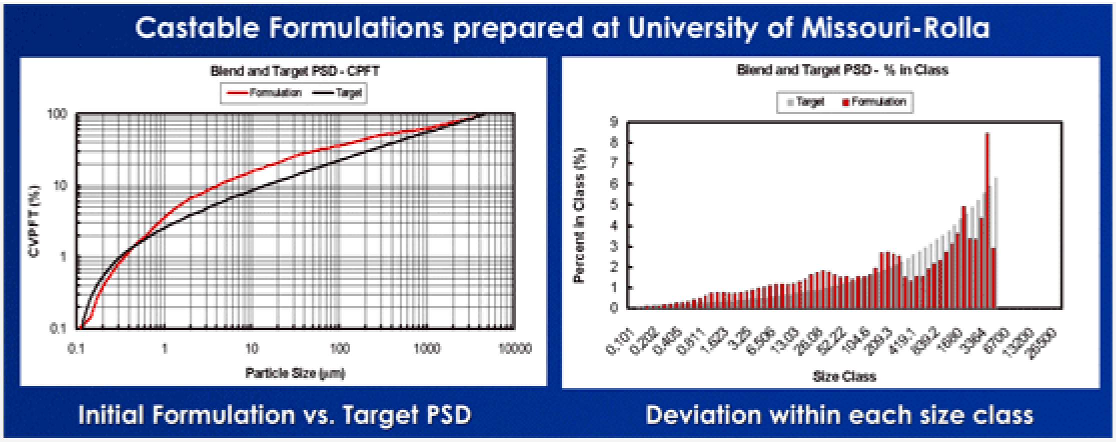
Micrographs showing the glazed surface of fused silica. Melting of glaze prior to reaching the decomposition temperature prevents escape of gases, such as CO_2 resulting into porosity

A glaze material with low coefficient of thermal expansion (CTE) <0.5 /°C and low reactivity with molten Al was selected.
CTE depends on the crystalline phases and the content of glassy matrix within the glaze
Al2O3 (29.2 wt.%), B2O3 (5 wt.%), K2O (5 wt.%), Li2O (11.3 wt.%), SiO2 (49.5 wt.%)


Aluminum Reactivity Test
Glaze
Molten Al
Sample was left in molten Al at 750 °C for 24 hrs
A wedge-shaped piece was cut out from an inch thick cross-section of the fused silica stalk tube
One surface of the wedge-shaped piece was glazed and tested for wetting and reactivity with molten Al


Reaction zone
Al
04-0056-06
24hrs.
300µm
Glaze
No reaction
04-0056-05
24hrs.
300µm
Molten Al reacting with unglazed surface of fused silica
Glaze prevents attack from molten Al up to 24 hrs


Particle Size Distribution
Computer model for selection of optimum aggregate to minimize permeability



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