Surface Treatment of Refractories Using High Density Infrared Heating

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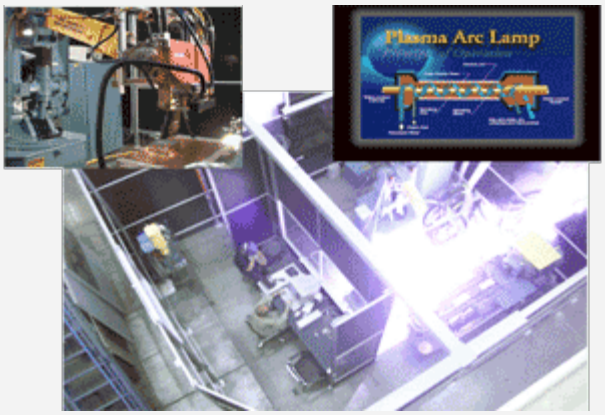
Introduction:

- Refractories play crucial role in IMF industries
- Major degradation mechanism has been penetration and corrosion by molten metals or glass
- Methods to reduce penetration, wetting, and corrosive chemistry would improve refractory life



Advantages of Using High Density IR Heating:

- Compared to laser, can cover large areas
- Short wavelength irradiation
- Fast heating and cooling rates
- Very high temperatures attainable
- Potential for continuous processing

Results - Reduce Porosity for Improved Corrosion Resistance

Several Refractories Used in Initial Study

- All commercial sources
  - High alumina castable
    - 88% Al2O3-4% SiO2-4% Calcium aluminate-4% Mg; 3.2 g/cm3 with ~12% porosity
  - Aluminosilicate
    - 88% Al2O3-4% SiO2; 2.9 g/cm3 with ~16% porosity
- All were fired to =800°C prior to IR treatment and Non-IR treated materials fired to 1500°C for 1 h

Results - Surface Chemistry and Coatings

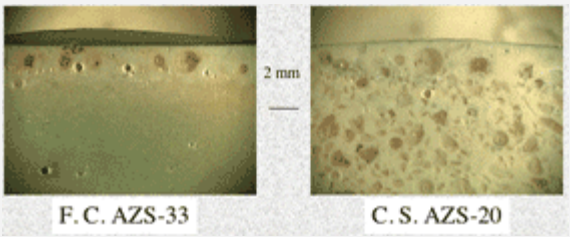
Two Types of AZS Glass Contact Refractories Tested

- Fused cast with 33% ZrO2 with 3-9% porosity (F.C. AZS-33)

Cast and sintered with 20% ZrO2 with 17-20% porosity (C.S. AZS-20)

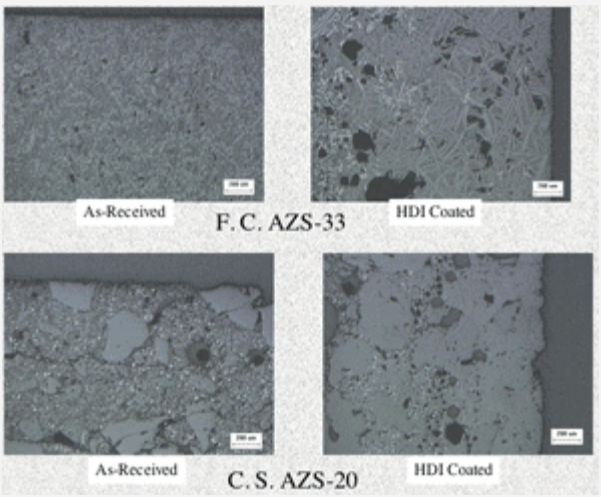
- ZrO2 slurry equivalent to 200 µm thick applied to surface and then IR treated

Cross-Sections of HDI Coated AZS



- Coatings much thicker than amount of ZrO2 painted on surface
- Bubbles within coating and at interface
- Trapped internal porosity
- Trapped gases in glass phase of F. C. AZS-33

Significant Mixing Occurs Between Applied ZrO2 Coating and Underlying AZS

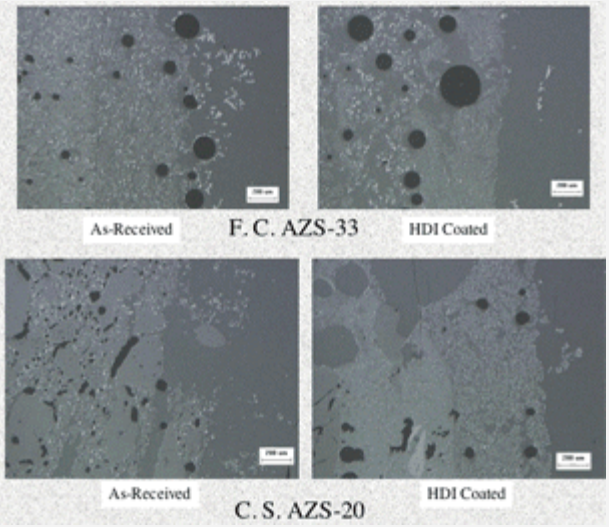


- Formation of fine ZrO2 dendrites in HDI affected region
- X-ray identified tetragonal ZrO2 on HDI coated surfaces
- Porosity (trapped gases and/or shrinkage)

Corrosion Testing

- Window glass plus 10 w/o NaCO3 mixture
- 1400°C immersion test
- 80 hour exposure times

Microstructure of AZS-33 After 80 Hour Test



- Considerable release of material from surface
- Boundary layer formation
- Retention of HDI fine dendritic structure

HDI Treatment of AZS Refractories

- Demonstrated that ZrO2-rich coatings could be produced on AZS refractories using HDI thermal treatments
- Mixing occurs between applied coating and underlying refractory
- Fine dendritic ZrO2 structure developed
- Porosity also generated
- Coatings help form boundary layer during glass contact
