WEDNESDAY, AUGUST 25, 2004, A.M.

SESSION 39: FOURTH INTERNATIONAL SYMPOSIUM ON ADVANCES IN REFRACTORIES FOR THE METALLURGICAL INDUSTRIES

BASIC SCIENCE (I)
Sponsors: Materials Science and Engineering, The Metallurgical Society of CIM, The Refractory Ceramics Division of the American Ceramic Society and The Canadian Ceramic Society.
Room: Webster B
Chairmen: M. BOUSSUGE, École des Mines de Paris, Evry, France, and
V. PANDOLFELLI, Universidade Federal de Sao Carlos, Sao Carlos, Brazil

PAPER 39.1 — 8:05
IMPROVING HYDRATION RESISTANCE OF AL POWDER USING INORGANIC-ORGANIC HYBRID COATINGS.

S. ZHANG, B. ZHU and W.E. LEE, The University of Sheffield, Sheffield, United Kingdom

Al powder is used extensively as an antioxidant in carbon-containing bricks, but it cannot be used directly in water-based carbon-containing castables due to its hydration tendency. To overcome this problem, in this work, SiO_2-PVA (polyvinyl alcohol) inorganic-organic hybrid coatings have been prepared via sol-gel processing, and used to coat Al powder. The hydration behaviour of uncoated and coated Al powders has been investigated in water at 60 or 100^oC for 36h by examining phase and microstructural changes. While significant hydration is detected in uncoated Al powder, no obvious hydration is detected in coated Al powder, indicating that its hydration resistance has been greatly improved. Oxidation resistance of graphite coexisting with uncoated or coated Al powder was also investigated in air at 1250^oC for 1.5h. The oxidation ratio of graphite coexisting with coated Al powder was similar to that of graphite coexisting with uncoated Al powder, indicating that both powders showed similar antioxidising behaviour. This, along with the much improved hydration resistance, makes the coated Al powder a potential antioxidant in carbon-containing castables systems.

PAPER 39.2 — 8:30
MARANGONI EFFECT IN SLAG LINE DISSOLUTION OF REFRACTORIES.

Y. CHEN, G. BROOKS, K.S. COLEY, McMaster University, Hamilton, Ontario, Canada, and
S. NIGHTINGALE, University of Wollongong, Wollongong, Australia

The Marangoni effect plays a significant role in slag line corrosion of refractories. Previous experimental studies for various refractory/slag systems and mathematical models have been reviewed. In the current study, the high temperature dip technique has been used to investigate the dissolution of MgO refractory in SiO_2-CaO-FeOx-MgO slag and Al_2O_3-SiO_2-CaO-FeOx-MgO slag at 1530$_o$C. In both systems, significant slag-line corrosion was observed. The rate of attack of the MgO was marginally slower in the case of slags containing alumina. A semi-empirical model of that phenomenon described reasonably well the observed progression of corrosion with time. Further work is proposed to evaluate this model.

PAPER 39.3 — 8:55
RELATIONSHIP BETWEEN GLASS FIBER CONTENT AND PARTICLE SIZE OF SPRAYABLE TUNDISH LINING (MGO) ON THE WETTABILITY OF MOLTEN STEEL/MGO SYSTEM.

E. CANDAN, Y. TUREN, Zonguldak Karaelmas University, Karabuk, Turkey,
K. KOCATEPE, Gazi University, Ankara, Turkey, and
E. BAS, ERDEMIR, Eregli, Zonguldak, Turkey

In this study, wettability between sprayable tundish lining (MgO) and molten steel was investigated by using sessile drop method. Content of glass fiber (SiO_2) in the MgO varied between 0 to 8 wt% whereas mean particle sizes of the MgO were 25, 75, 150 and 300μm. Experimental results revealed that contact angle (θ) of sessile drop on the MgO was not altered by the addition of glass fiber up to 1wt.% whereas above 2 wt.% addition decreased the θ considerably. Contact angle, θ, increased considerably with increasing MgO particle size. SEM analysis showed deposition of glass phase was present at the interface as the finer MgO particles were used.

PAPER 39.4 — 9:20

INFLUENCE OF ADDITIVES ON MICROSTRUCTURAL CHANGES OF NITRIDE BONDED SIC REFRACTORIES.

A.A. NOURBAKHSH, S.H. SALARIAN, Azar Refractories Company, Esfahan, Iran, A. SHOJAI and F. GOLESTANI-FARD, Iran University of Science and Technology, Tehran, Iran

In this paper microstructural development of nitride-Bonded SiC refractories is reported in presence of Al_2O_3, MgO and Urea additives .The samples were prepared by mixing, shaping and firing at 1400-1500^{O}c in a controlled atmosphere furnace. Phase analysis, microscopic observation and mechanical evaluation were taken for microstructural investigations.

The strength of samples doped with Al_2O_3 was first increased and then decreased at higher amount of Al_2O_3 additions. The addition of MgO decreased the strength while the urea showed an improving effect on strength.

These phenomena could be attributed to microstructural evolution and mainly to liquid phase formation and grain morphology. It was found that the additives such as Al_2O_3, MgO and urea could modify the microstructure in terms of phase formation and texture modification, which in terms influences the mechanical behavior.

PAPER 39.5 — 9:45

EFFECTS OF CERAMIC COATING ON OXIDATION RESISTANCE OF CARBON MATERIALS WITH SIC GRADIENTS.

O. YAMAMOTO and Z.-E. NAKAGAWA, Akita University, Akita, Akita, Japan

After the formation of a concentration gradient of SiC within C-C composite, either zircon or mullite thin films were coated on the surface by sol-gel process. Oxidation resistance tests of as-prepared composites with a couple consisting of a ceramic thin film and a SiC-gradient were then carried out in air at the temperature range from 600 to 1600℃. By the coating of zircon with a thickness of 1.5 μm, a pronounced oxidation resistance was observed; the mass loss by oxidation was almost negligible at 1000℃ and one hundredth of original composite at 1400℃. In the case of the coating of mullite with a thickness of 1.0 μm, the marked improvement in oxidation resistance over the whole temperature range examined, from 600 to 1600℃, was found with the combination of a SiC-gradient and a mullite thin film.

COFFEE BREAK — 10:10 – 10:40

PAPER 39.6 — 10:40

EFFECT OF STRUCTURE ON OXIDATION RATE OF MGO-C REFRACTORIES.

H. SUNAYAMA and M. KAWAHARA, Kumamoto University, Kumamoto, Japan

Oxidation rates of the cubic specimens, which were prepared by cutting the shaped magnesia-carbon bricks, were measured continuously with a thermo balance in the temperature range from 1273 to 1823 K in N_2-O_2 and Ar-O_2 mixed gas with 2.1×10^4 and 3.7×10^2 Pa of oxygen partial pressure respectively. The effect of the graphite content, the maximum grain size of magnesia clinker and the oxygen concentration in the atmospheric gas on the oxidation rate for the MgO-C refractory has been investigated. The value of effective diffusion coefficient of O_2, which diffuses through the porous decarburized layer, decreased with the decreasing of the porosity and the oxygen concentration in the external gas phase. It was speculated that the dense layer formed easily due to the high tortuosity of pores and the low recession speed of the carbon interface in the MgO-C bricks.

PAPER 39.7 — 11:05

THERMAL SHOCK RESISTANCE OF BAUXITE-BASED B-SIALON BONDED CORUNDUM MATERIALS

Z. LIU, H. ZHANG, X. ZHONG, High Temperature Ceramics Institute, Zhengzhou University, Zengzhou, Henan, China

Thermal shock resistant properties of reaction sintered bauxite-based β-Sialon bonded corundum have been investigated, and the results are compared with those of Al_2O_3 based counterpart. It is found they all have very good thermal shock resistance. Their residual strength ratios after one thermal shock cycle at ΔT=1200^{o}C and ΔT=1350^{o}C are 61-73% and 53-65% respectively. TSR parameters are calculated based on thermal expansion, modulus of elasticity, and fracture toughness determined. The reasons for improved TSR of these composite materials are discussed.

PAPER 39.8 — 11:30

DETERMINATION OF KINETIC PARAMETERS OF MGO-C

B. HASHEMI, Z. Moghimi, Z. A. NEMATI, s.k. Sadrenezhaad, Sharif University of Technology, Tehran, Iran.

Based on the kinetics relationships of a solid – gas model, a software was developed for the prediction of oxidation. Preliminary prediction of oxidation by the software and experimental results of MgO-C refractories were studied and compared. By using the obtained data from this approach, the effective diffusion coefficient, intermolecular diffusion coefficient and diffusion activation energy in the MgO-C refractories, containing various amount of graphite were obtained at different temperatures.

First of all, the prediction by the software was very compatible with experimental results, for different oxidation mechanisms in the MgO-C refractories.

The results showed that pore diffusion is the predominant oxidation mechanism in this system. The results indicated that when graphite content was above 10wt%, the intermolecular diffusion coefficient was independent from graphite content, and it was closed to a constant value at each temperature.