

**WEDNESDAY, AUGUST 25, 2004, P.M.**

**SESSION 49: FOURTH INTERNATIONAL SYMPOSIUM ON ADVANCES IN REFRACTORIES FOR THE METALLURGICAL INDUSTRIES**

**COPPER (II) – NEW MATERIALS**

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 A

Chairmen: N. BEHNOOD, PTMC Inc., Montréal, Québec, Canada, and  
J. BENNETT, USDOE, Albany, Oregon, U.S.A.

**PAPER 49.1 — 14:00**

**MAGNESIUM ALUMINATE SPINEL RAW MATERIALS FOR HIGH PERFORMANCE REFRACTORIES FOR STEEL LADLES.**

R.P. RACHER, Alcoa World Chemicals, Leetsdale, Pennsylvania, U.S.A.,  
R.W. MCCONNELL, Alcoa World Chemicals, Bauxite, Arizona, U.S.A., and  
A. BUHR, Alcoa World Chemicals, Frankfurt, Germany

High quality steel production requires extended treatment of the steel in the steel ladle. This has a remarkable impact on the steel ladle refractories, e.g. the need for high performance functional refractories like purging plugs. Operational changes such as increasing tapping temperatures, longer hold times and more aggressive secondary metallurgy are countered by the need for thinner refractory linings and longer refractories life. These combined factors have led to a resurgence in interest in magnesium aluminate spinel raw materials. Magnesium aluminate spinels have been used in steel-making refractories for many years, in a variety of different forms. This paper reviews the production, properties and performance of spinels. Recent developments in the applications of spinels will also be discussed.

**PAPER 49.2 — 14:25**

**NON-FIBROUS INSULATING CASTABLE WHICH UTILIZE MICRO POROUS AGGREGATE.**

Y. SAKAMOTO, K. FUJITA and T. KIKUCHI, Towa Refractory Engineering Co. LTD., Kani-City, Gifu-pref, Japan

Ceramic fibers were classified as a category 2 carcinogen by EU. Therefore we developed non-fibrous insulating castable which utilize micro porous aggregate, which is composed of Calciumhexaluminate. Although at the beginning we applied alumina cement as binder for non-fibrous insulating castable, this kind of formula had a poor resistance of spalling. We developed non-fibrous insulating castable without alumina cement. This solved a problem which previous formula had a poor resistance of spalling. We applied a new insulating castable for reheat furnace in steelworks, then we could achieve good result which is in condition equivalent to ceramic fiber insulating castable.

**PAPER 49.3 — 14:50**

**SYNTHESIS OF NANOSIZED TITANIUM CARBIDE BY NOVEL MG-THERMAL REDUCTION PROCESS.**

D.-W. LEE and B.-K. KIM, Korea Institute of Machinery and Materials, Chang-won, Kyong-nam, Republic of Korea

Nano-phase titanium carbide was synthesized by Mg-thermal reduction process using a novel route of Mg-thermal reduction. The processes are based on 1) feeding of  $TiCl_4 + C_xCl_4$  ( $x = 1, 2$ ) solution into liquid magnesium, 2) Mg-reduction of metal chlorides, 3) TiC formation by the reaction of released Ti and C atoms, and 4) vacuum separation of residual liquid phases of Mg and  $MgCl_2$ . In this study, the process for titanium carbide production with composition close to stoichiometry and the minimum content of impurities was optimized with the various process parameters such as concentration of initial solution, its feeding rate and reaction temperature, as well as a kinetic study.

COFFEE BREAK — 15:15 – 15:45

PAPER 49.4 — 15:45

SYNTHESIS OF DIFFERENT TRADITIONAL AND COMPOSITE REFRACTORY AGGREGATES FROM KYANITE.

I. VERNETT-PATINO, H. BALMORI-RAMÍREZ, Instituto Politécnico Nacional, Mexico,

J. AGUILAR-SANTILLAN, F.N. CUNHA and R.C. BRADT, The University of Alabama, Tuscaloosa, Alabama, U.S.A.

Kyanite is an aluminosilicate mineral that has been widely used for the production of refractory products for industrial applications. Kyanite provides a high alumina content, readily produces mullite during firing, good hot strength of products and can be adapted to produce dimensional stability of products during firing. This research addresses the application of kyanite in mixes to produce (i) dense mullite aggregates with the addition of alumina, (ii) dense composite refractory aggregates of forsterite / spinel with additions of magnesia, and (iii) dense cordierite aggregates with the addition of talc. Effects of attrition milling and conventional ceramic processing are addressed as they affect the properties of these unique aggregates.

PAPER 49.5 — 16:10

NANOSTRUCTURED CU-AL<sub>2</sub>O<sub>3</sub> COMPOSITE PRODUCED BY THERMOCHEMICAL PROCESS.

D.-W. LEE and B.-K. KIM, Korea Institute of Machinery and Materials, Chang-nam, Kyoung-nam, Korea.

Nanostructured Cu-Al<sub>2</sub>O<sub>3</sub> composite powders were synthesized by thermochemical process for an electrode application. The synthesis procedures are 1) preparation of precursor powder by spray drying of solution made from copper and aluminium nitrates, 2) heat treatments to evaporate volatile components in the precursor powder and synthesis of nanostructured CuO+Al<sub>2</sub>O<sub>3</sub>, and 3) CuO reduction by hydrogen into Cu. The suggested procedures stimulated the formation of the gamma-Al<sub>2</sub>O<sub>3</sub>. The mean particle size of the final composite powders was 20 nm, and the electrical conductivity and hardness in the hot-extruded bulk were competitive with Cu/Al<sub>2</sub>O<sub>3</sub> composite by the conventional internal oxidation process.

PAPER 49.6 — 16:35

REMOVING CARBON PRECIPITATION IN ANODE KILN LINING OF SARCHESHMEH COPPER COMPLEX BY CHANGING THE BRAND (QUALITY) OF CONSUMED REFRACTORY BRICKS.

N. KHALILI and M. HOSSEINZADEH, Pars Refractories Co., Iran

By changing the quality of consumed refractory bricks in burner zone of sarcheshmeh copper complex anode kiln removing of carbon precipitation phenomenon was studied. For blister deoxygenation LPG is blowing in anode kiln and cause destoring microstructure and bonding of refractory bricks. Studies are shown that in a part of the bricks which have a temperature of 800 – 1000°C, iron content phases in magnesia – chromite bricks are like catalyst and cause increasing the rate of carbon precipitation reactions. In a way that in comparison of two bricks with best and medium quality with different analysis, this problem is more critical in best quality bricks containing high iron oxide. Therefore special magnesia - spinel bricks suggested and installed in burning zone.