Abstract

Preparation and Mechanical Properties of Monolithic Refractories Containing *In-Situ* Calcium Hexaluminate

KHAJORNBOON JIRAPRABHA

Kyoto Institute of Technology

Monolithic refractories are widely used in metal and steel industries. The important raw material as calcium aluminate cement (CAC) is used and calcium hexaluminate (CA6) phase is formed in hexagonal plate-like morphology. This microstructure helps to enhance toughening properties as resistance for fracture and thermal shock.

In the present study, monolithic refractories containing *in-situ* CA6 was prepared under controlling CA6 content and microstructure. The results showed that CA6 could be prepared by using CAC and sintered Al_2O_3 in stoichiometric composition as 1:6 mol of CaO:Al_2O_3. The sintering condition had strong influence on controlling CA6 quantity and grain growth. The utilization of small Al_2O_3 grain (75 µm) accelerated the CA6 formation at lower temperature due to high surface area. The addition of SiO_2 helped to enhance hexagonal plate-like microstructure but the presence of gehlenite (C2AS) obstructed CA6 formation.

The mechanical properties as fracture toughness (K_{IC}) and effective fracture energy (γ_{eff}) were measured. It was found that big grain Al_2O_3 (550 µm) samples with SiO_2 addition enhanced high K_{IC} and γ_{eff} because of toughening mechanisms as crack deflection and strong bond breaking. The results of high surface roughness at fractured surface were the evidences of high energy consumption from above mechanisms. However, plate-like microstructure was not only obtained from high *in-situ* CA6 content, but high apparent porosity was also gained which led to weakening of materials and decreasing both K_{IC} and γ_{eff}.

Finally, thermal shock damage resistance parameter R'''' was determined but the achieved values were lower than usual of commercial refractories. Thermal shock parameters as γ_{eff}, modulus of rupture (σ_f) and Young's modulus (E) were evaluated. High σ_f was the main reason of low R''''. Other thermal shock resistance as R and R_{st} was calculated to confirm R''''. The thermal shock behaviors were monitored by measuring the change of σ_f and E upon increase temperature difference. Samples with big grain Al_2O_3 showed high thermal shock damage resistance (R'''' and R_{st}) due to high γ_{eff}. Nevertheless, samples with small Al_2O_3 grain and SiO_2 addition expressed high thermal shock fracture resistance R led to catastrophic decrease of both σ_f and E.