Investigation on Synthesis and Antioxidant Properties of Calcium Hexaborid

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1- Introduction

Calcium hexaboride has high melting point (2372 K), high hardness (27 GPa), low density (2.45 g/cm3), high Young's modulus (379 GPa) and low thermal expansion coefficient. This material has capability for being used in composite and as an antioxidant in oxide-graphite refractories. Calcium hexaboride can be synthesized by different processes such as hydrothermal, solid state and combustion synthesis. CaB_6 as an antioxidant in MgO-C refractories can reduce the oxidation of graphite. In this study synthesis and application of CaB6 as an antioxidant are investigated.

2- Experimental

Boric acid and calcium hydroxide in autoclave at 200ºC and pressure of 2 bar for 3h were mixed until hydration of calcium hydrated borate (CaB_6O_{10}. nH_2O) obtain. After calcination of the samples at 400ºC for 2h CaB_6O_{10} was achieved and then it was mixed with reduction agents such as Mg, Al, or Si and then pressed as a pellet. The pellets were calcined at 650-900ºC in carbon bed. After calcination, CaB_6 and different oxides such as MgO, Al_2O_3 and SiO_2 were established. Then samples milled and then leached to reduce oxide impurities. Different origin synthesis CaB_6 and Al powders were added to MgO, graphite and novolak resin and mixed. Different batches were pressed in the form of 40 mm diameter samples with 800 kgf/cm^2 pressure. Then, oxidation resistance of samples at 800-1400ºC for 4h in air atmosphere were measured.

3- Results and Discussion

The results of combustion synthesis of CaB_6 from mixing of CaB_6O_{10} and Mg at carbon bed after calcination at different temperatures (Fig. 1) show that calcium and magnesium boride are presented as minor phases. After leaching according to Fig. 2C high purity calcium hexaboride with high purity by this method was achieved.

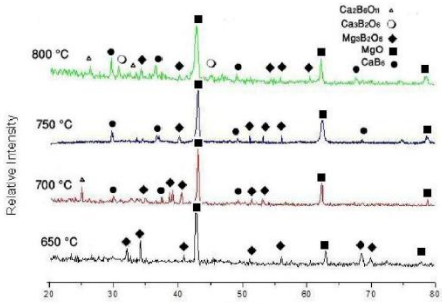

Fig. 1 XRD results of pellets containing CaB_6O_{10}+Mg after heat treatment at different temperatures in carbon bed

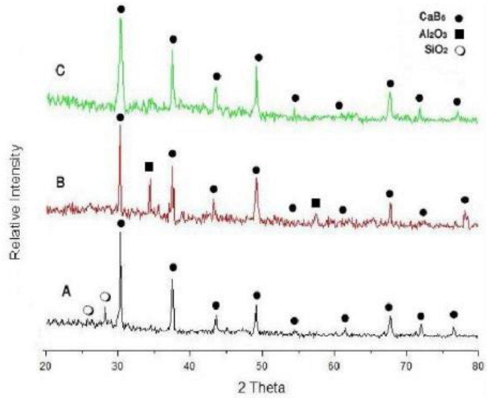

Fig. 2 XRD results of various synthesized CaB_6 after leaching a) with silicon; b) with aluminum; c) with magnesium

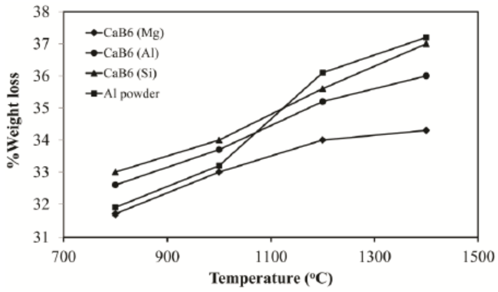

Fig. 3 Weight loss of samples containing CaB_6 or Al at different temperatures in oxidation atmosphere

Fig. 3 shows the weight loss of MgO-C refractories containing different kinds of CaB_6 that is synthesized with reduction agent of Mg, Al, and Si. The results show that the CaB_6 obtain from mixing of CaB_6O_{10} and Mg as reduction agent has better oxidation resistance capability in comparison with Al.

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4- Conclusions

1. Combustion synthesis of CaB_6 was carried out by mixing CaB_6O_{10} with Mg and then leaching can produce purer CaB_6 compared to synthesis from mixing CaB_6O_{10} with Al and Si.
2. MgO-C containing CaB_6 has better oxidation resistance capability in comparison to normal refractories with Al as an antioxidant.