Fabrication process, microstructures, and mechanical properties of alumina fabricated from amorphous powders by spark plasma sintering(SPS) process

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1. Introduction

Generally, the widespread applications of alumina are limited due to the low fracture toughness.[1] Recent studies have reported that the fracture toughness of alumina increases when large platelike grains are randomly dispersed in matrix.[2] In this study, fabrication of alumina directly sintered from amorphous powder by spark plasma sintering process was tried.

2. Experimental Procedure

The amorphous powder was prepared by drying precursor material of aluminium nitrate, then heating at 350℃ for 72h. The amorphous powder was spark plasma sintered at 1400℃ with different holding times. The microstructure of the specimens was observed by scanning electron microscopy(SEM). Vickers hardness and fracture toughness, K_{Ic}, were determined using an indentation technique method with a Vickers indenter with 19.6N load.

3. Results and Discussion

The relative densities of all alumina specimens sintered from amorphous powder at 1400 ℃ with holding time from 1min to 15mins by SPS were over 99%. The microstructure of sintered amorphous powder consists of fine grains whose size was below a few hundreds of nanometeres and anisotropic grains.[Fig1 (a)] These large platelike grains were uniformly distributed with random orientation. Hardness value of specimen sintered at 140 0℃and 1min holding time from amorphous powder was similar to that of specimens sintered on same condition from crystalline powder. However, hardness of specimens sintered from amorphous powder decreased with increasing holding time. Fracture toughness of sintered amorphous powder increased by 30%~65% rather than that of specimens sintered from crystalline powder.[Fig1 (b)] The in-situ formed uniform alumina platelike grains were expected to increasing fracture toughness by bridging and deflection of cracks during fracture.

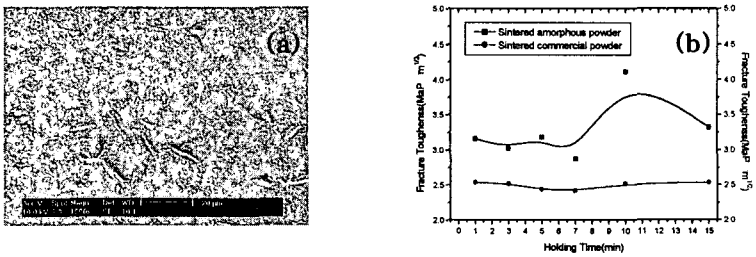

Fig 1. (a)Microstructure and (b)Fracture toughness of sintered amorphous powder

4. References

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