Abstract of Main Thesis

Title of Thesis

Study on Microstructure and Mechanical Properties of Ceramic Composites Produced by Electromagnetic Sintering

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Abstract on the Content of the Applicant's Thesis

Recently, electromagnetic sintering process has attracted attention from the advantages in materials processing compared to the conventional processes. Electromagnetic wave energy transforms into heat inside the material, which results in significant energy savings and reduction in process time. However, the relationship between microstructure and mechanical properties on sintered materials has not been clearly studied. In order to develop the advanced materials, the present study focused to ceramic composite materials sintered by single-mode microwave and spark plasma sintering process. The microstructural changes effects on mechanical properties were investigated in detail. Before sintering, the high energy mechanical milling is applied to SiC-ZrO_2, Al_2O_3-ZrO_2 and Si_3N_4-ZrO_2 with ratio 1:1, in order to obtain the homogeneous dispersion and finer particles.

In case of microwave, the microstructure of finer particles and homogeneously dispersed SiC-ZrO_2 after milling was better in sintered region. This is because, ZrO_2 have an effect on the absorption of the microwave energy and after mechanical milling, homogeneous dispersion forming a network microstructure. The microstructure in sintered region was smaller for the coarser particles which obtained by heterogeneous non-milled powder mixture. The result of hardness Vickers test was higher for the powder homogeneously dispersed SiC-ZrO_2 after milling and sintered by microwave.

By spark plasma sintering, the microstructure, the mechanical properties and the densification behavior of the SiC-ZrO_2, Al_2O_3-ZrO_2, and Si_3N_4-ZrO_2 composites were investigated. The samples with optimum milling time for 144ks forming a network microstructure and resulted in improved relative density and mechanical properties such as Vickers hardness, bending strength and fracture toughness. The non-milled powder mixtures and too long milling time powder mixtures have low density and low mechanical properties sintered by spark plasma. The concluding remarks in this study is the microstructure with homogeneous particle dispersion forming a network can be considered a remarkable design tool for improving the mechanical properties of SiC-ZrO_2, Al_2O_3-ZrO_2, and Si_3N_4-ZrO_2 as well as other ceramic composite materials.