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INFLUENCE OF GRAİN SİZE ON MECHANICAL PROPERTIES OF Al_2O_3 – SiC COMPOSİTES

Hilalnur ŞEKER, Ali Osman KURT,
Liviu BRÂNDUŞAN, George ARGHIR

INFLUENCE OF GRAIN SIZE ON MECHANICAL PROPERTIES OF Al_2O_3 – SiC COMPOSITES

Composite material of Al_2O_3/SiC was prepared by pressing Al_2O_3 and SiC powders. The mechanical properties, including flexural strength, compression strength, hardness, and resilience were studied. The amount of SiC was 20, 30, and 40 vol. %. Sintering was done at 1650 ^oC for 1 h soaking time in air. Porosity decreases as grain size of SiC is increasing. As increasing the particle size the resistance of flexion decreases, the resistance of compression is decreasing, HRA is highest for 20 % vol. SiC, and resilience is highest for 40 vol.% SiC.

Keywords: Al_2O_3/SiC composites, flexural strength
Cuvinte cheie: compozite Al_2O_3/SiC, rezistenţă la încovoiere

1. Introduction

In the class of engineering ceramics alumina (Al_2O_3) is one of the most cost effective and widely used materials. It is certain that Al_2O_3-based composites have been extensively studied. These type of materials have excellent properties such as high hardness, low electrical conductivity, good chemical stability, and oxidation resistance. There are many researches focusing on particle-dispersed Al_2O_3 composites in order to improve their mechanical properties including flexural strength and resilience. The second phase particles contain SiC

[1 – 4], ZrO2 [5, 6], TiN/TiC/TiO2 [7–9], BN [10], Y2O3 [11]. Al_2O_3 ceramic has a good sintering property, excessive addition of carbide or nitride results in the generation of pores.

In present work, the mechanical properties of pressed Al_2O_3/SiC composites are studied. The effects of porosity, grain size of SiC, and SiC addition on strength and resilience of Al_2O_3-based composites are analyzed.

2. Experimental procedure

Al_2O_3 and SiC raw powders were used. Particle size of Al_2O_3 was 5 µm. There were used three different sizes of SİC (40-80 µm, 80-125 µm, 80-125 µm). Al_2O_3 and SiCx wt. % powders (x = 20, 30, 40) were homogenized in a planetary mill for 1 h. Anhydrous alcohol was sprayed to the powders for granulation.

The powders were shaped in the size of 7.5mm×7.5mm×40mm for bending and resilience and in shaped cylindrical pills (11.285 mm diameter) for compression tests. The powders were pressed under a pressure of 400 MPa. The composite samples were sintered at 1650 ºC in air. Every surface of the samples was polished after sintering.

3. Results and discussion

- **Sintering porosity**

The sintered sample density, using Archimedes' immersion technique in distilled water, was transformed into porosity, Figure 1.

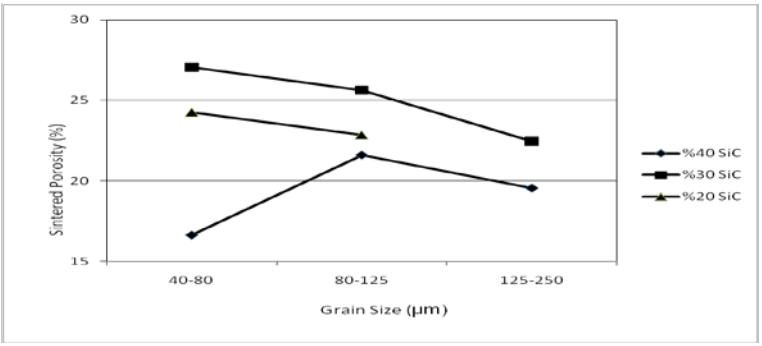

Figure 1. Sintered porosity versus grain size

Porosity decreases as grain size of SiC is increasing.

- **Mechanical properties**

The flexural strength, resistance of compression, A Rockwell hardness, and resilience as functions of sintering temperature and SiC concentration are presented in Figures 2, 3, 4, and 5.

The flexural strength of Al_2O_3/SiC with 30 %SiC and with grain size of SiC 40-80 μm reaches maximum 68.96 MPa on Galdabini testing machine.

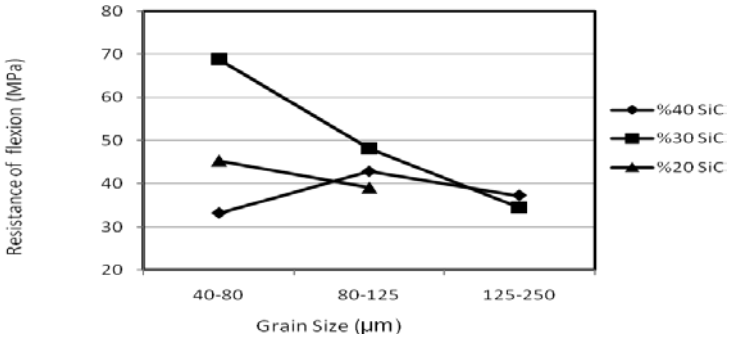

Figure 2. Resistance of flexion versus grain size

The porosity significantly influences the mechanical properties for ceramic materials and another important factor influencing the strength is grain size.

According to the Griffth theory [12], strength of ceramics is influenced by the size of inherent flaw.

And the size of inherent flaw is proportional to the grain size for ceramics materials, so grain-refining can improve the strength for polycrystalline materials.

For compression test the specimens were surface ground and polished before testing.

The compression test was also made on Galdabini testing machine.

The maximum result of compression test is 277 MPa for Al_2O_3/SiC with 20 % SiC and with grain size of SiC 40-80 μm.

The highewst values for HRA hardness are for 20 vol. % SiC and for 40-80 μm and 80-125 μm grain size, the smallest values are for 30 vol.% SiC with grain size between 80-125 μm and 125-250 μm. For 40 vol. % SiC the data is not clear.

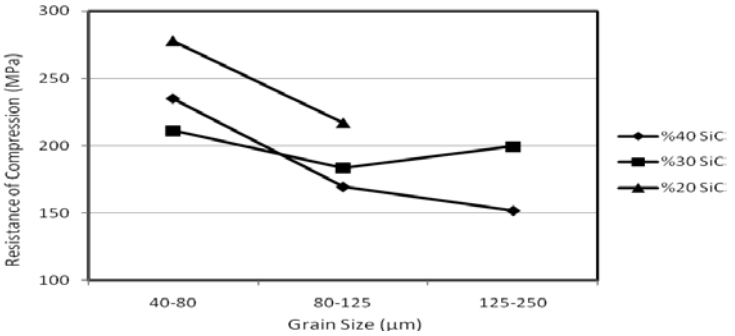

Figure 3. Resistance of compression versus grain size

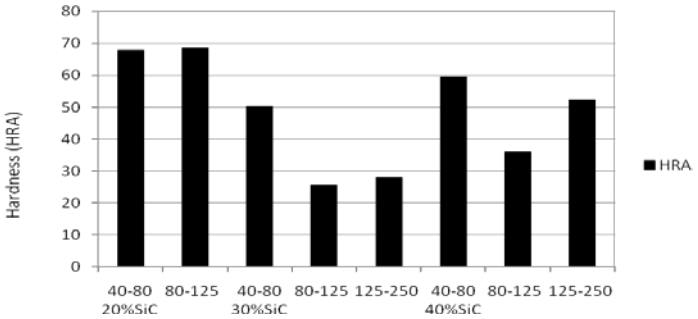

Figure 4. HRA Hardness versus SiC content and grain size

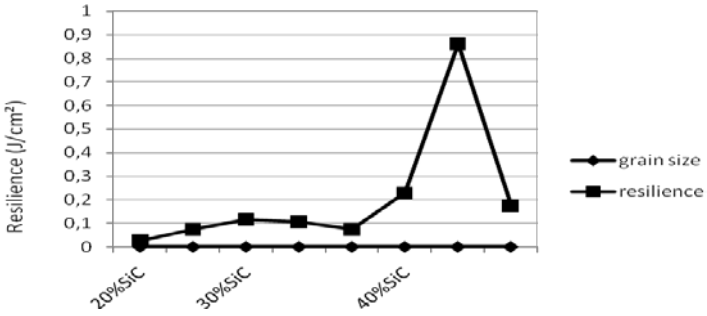

Figure 5. Resilience versus SiC content

The resilience value is highest for 40 vol.% SiC, the other values are almost constant and low. Surprising this result is not in good agreement with the previous results.

4. Conclusions

■ As increasing the particle size the resistance of flexion decreases. Because amount of contact between the particles also decrease. The greatest decrease is seen with 30 vol. % SiC.

■ Analyses of resistance of compression shows that with increasing the particle size of SiC resistance of compression decreases. Because of the same situation as with flexion parameters. The ceramical materials contain small contacts.The maximum result of compression test is 277 MPa for Al_2O_3/SiC with 20% SiC and with grain size of SiC 40-80 µm.

■ The HRA hardness is maximum for 20 vol. % SiC and for 40-80 µm and 80-125 µm grain size, the smallest values are for 30 vol.% SiC with grain size between 80-125 µm and 125-250 µm.

■ At the 40 vol.% SiC the resilience is at maximum.

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INFLUENŢA GRANULAȚIEI ASUPRA PROPRIETĂȚILOR MECANICE ALE COMPOZITULUI Al_2O_3/SiC

Rezumat: Materialul compozit de Al_2O_3/SiC a fost pregătit sinterizând Al_2O_3 şi pulberi de siliciu. Au fost studiate proprietăţile mecanice, inclusiv încovoiere, rezistența la compresiune, duritate şi de rezistenţă. Cantitatea/suma de carbură de siliciu a fost de 20, 30, şi 40 % din volum. Sinterizare a fost făcută la 1650 °C timp de 1 h, cu timp de înmuiere în aer. Au rezultat următoarele concluzii: porozitatea scade pe măsură ce dimensiunea grăuntelui de carbură de siliciu este în creştere. Şi creşterea dimensiunii particulelor scade rezistenţa de încovoiere; rezistența de compresiune este în scădere; HRA este cel mai mare la 20 % din volum SiC şi rezistenţa este mai mare la 40 % din volum carbură de siliciu.

Ing. Hilalnur ŞEKER
Facultatea de Ştiinţa şi Ingineria Materialelor
Prof. Dr. Ing. Ali Osman KURT
Facultatea de Inginerie Metalurgica și Materiale
Universitatea din Sakarya, Turcia
Prof. Dr. Ing. Liviu BRÂNDUŞAN
Prof. Dr. Ing. George ARGHIR
Facultatea de Ştiinţa şi Ingineria Materialelor
Universitatea Tehnică din Cluj Napoca
membri AGIR