Composite material of Al₂O₃/SiC was prepared by pressing Al₂O₃ 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 °C 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: Al₂O₃/SiC composites, flexural strength
Cuvinte cheie: compozite Al₂O₃/SiC, rezistență la încovoziere

1. Introduction

In the class of engineering ceramics alumina (Al₂O₃) is one of the most cost effective and widely used materials. It is certain that Al₂O₃-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 Al₂O₃ composites in order to improve their mechanical properties including flexural strength and resilience. The second phase particles contain SiC.
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 Al₂O₃/SiC composites are studied. The effects of porosity, grain size of SiC, and SiC addition on strength and resilience of Al₂O₃-based composites are analyzed.

2. Experimental procedure

Al₂O₃ and SiC raw powders were used. Particle size of Al₂O₃ was 5 µm. There were used three different sizes of SiC (40-80 µm, 80-125 µm, 80-125 µm). Al₂O₃ 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](image)

Porosity decreases as grain size of SiC is increasing.
### Mechanical properties

The flexural strength, resistance of compression, 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 $\text{Al}_2\text{O}_3$/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](image)

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

According to the Griffith 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 $\text{Al}_2\text{O}_3$/SiC with 20 \% SiC and with grain size of SiC 40-80 µm.

The highest 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 Al₂O₃/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.

REFERENCES


INFLUENȚA GRANULAȚIEI ASUPRA PROPRIETĂȚILOR MECANICE ALE COMPOZITULUI Al₂O₃/SiC

Rezumat: Materialul compozit de Al₂O₃/SiC a fost pregătit sinterizând Al₂O₃ și pulbere de siliciu. Au fost studiate proprietățile mecanice, inclusiv încovoiere, rezistența la compresiune, duritate și de rezistență. Cantitatea/suma de carbură de siliciu a fost de 20, 30, și 40 % din volum. Sinterizare a fost făcută la 1650 °C timp de 1 h, cu timp de înmierire în aer. Au rezultat următoarele concluzii: porozitatea scade pe măsură ce dimensiunea granulelui de carbură de siliciu este în creștere. Și creșterea dimensiunii particulelor scade rezistența de încovoiere; rezistența de compresiune este în scădere; HRA este cel mai mare la 20 % din volum SiC și rezistența este mai mare la 40 % din volum carbură de siliciu.