Fabrication of Al_2O_3-Ni Composites Using Ceramic Nanoparticles

Thitirat Theerabornkul and Sukasem Kangwantrakool*

School of Ceramic Engineering, Institute of Engineering, Suranaree University of Technology, Nakhon Ratchasima 30000, Thailand

**Corresponding author. E-mail: sukasem@yahoo.com*

ABSTRACT

In the present study, Al_2O_3-Ni composites were prepared by pressureless sintering. Nickel was used as a reinforcing material due to its high strength and toughness, both at room and elevated temperature. The purposes of this work are to improve the fracture toughness of the ordinary alumina with nickel additions and to investigate the effect of nickel on the characteristics and mechanical properties of Al_2O_3-Ni composites and also to study the proper sintering temperature for the optimum toughness of sintered composites. In this work, alumina nanoparticles were used as a matrix material and nickel as a particulate reinforcement material. The compositions were changed with different amount of nickel additions of 0, 10, 20 and 30 wt% in the composite. Then, the chemical composition, phase, microstructure and density of the sintered composites were characterized and also the flexural strength, hardness and fracture toughness were determined.

As the results, it was revealed that with the increase of nickel from 10 to 20 and 30 wt% in the sintered composite samples, the flexural strength was increased from 146.66 MPa to 178.08 MPa and 188.08 MPa, hardness was decreased from 8.59 GPa to 7.84 GPa and 4.59 GPa and fracture toughness was increased from 4.13 MPa.$m^{1/2}$ to 6.36 MPa.$m^{1/2}$ and 8.08 MPa.$m^{1/2}$, respectively. The optimum density of composite was obtained with sintering temperature at 1,400°C.

Key words: Alumina, Nanoparticles, Composites, Pressureless sintering, Mechanical properties

INTRODUCTION

Alumina is most widely used in the ceramics industry because of its high hardness, high strength and good chemical stability, although weak in the fracture toughness. Many attempts have been made to improve the mechanical properties of alumina ceramics, mainly the fracture toughness, by using reinforcement additions such as ductile metal particles (Rodeghiero et al., 1995). For such purpose, Ni ductile metal has the potential to improve the fracture toughness of Al_2O_3 ceramics because Ni possesses high toughness in a wide range of service temperature (Waterman and Ashby, 1991). However, Al_2O_3-Ni composites are currently the most important materials in a wide range of high strength and fracture toughness combinations and/with good oxidation and corrosion resistance especially at elevated temperature. (Fahrenholtz et al., 2000).

The purposes of this work are to develop/improve the fracture toughness of alumina with various amounts of Ni addition dispersed in alumina matrix, to study its influence on the relationship between compositions and mechanical properties and to determine their microstructure. Furthermore, Al_2O_3-Ni composites with different Ni contents were sintered by conventional low-cost pressure sintering method (Yang and Chen, 2000) which might be useful in practice for the production in ceramic industries.