Journal of the European Ceramic Society

Microstructure and thermoelectric properties of Al-doped ZnO ceramic prepared by spark plasma sintering

Radingoana, Precious M; Guillemet-Fritsch, S; Noudem, J; Olubambi, PA; Chevallier, G and Estourn, C

Abstract

The high thermal and low electrical conductivities of ZnO ceramics have hindered their thermoelectric applications. The doping of ZnO with group 3 elements can enhance the thermoelectric properties. In this work, Al (2 at%) doped ZnO powder was sintered using spark plasma sintering at varying parameters (such as temperature (550–700), pressure (250–500 MPa) and the temperature of pressure application (Room Temperature (RT) and Holding Time (HT))). Maximum relative density of 98.9% was achieved at a temperature and pressure of 650 °C and 250 MPa, respectively. The Al-doped ZnO ceramics improved in electrical conductivity which caused a decrease in the Seebeck coefficient because of increased carrier concentration. The reduction in the grain size due to inhibiting growth effects of aluminum lead to a decrease in the thermal conductivity through phonon scattering at the grain boundaries. Hence, ZT of 0016 at 500 °C was obtained. This study indicated that Al-doped ZnO ceramics can be sintered at very low temperature of 650 °C. These conditions allow to retain the nanostructure, which is beneficial in improving the thermoelectric properties.