MICROWAVE SINTERING OF ZNO-CUO

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ABSTRACT

After the discovery of nonohmic behavior in the ZnO system, sintered ZnO varistors have been widely used in electronic and electrical applications as surge protection devices. The nonohmic behavior is a grain boundary phenomenon in which n-type ZnO grains are surrounded by insulating grain boundary or charge depletion layers. At low voltages these grain boundaries prevent any current to pass through the device but when the field is increased, the varistor starts conducting. These devices are normally produced from suitably mixed powders of ZnO doped with several other metal oxides. The electrical properties are obtained by carefully controlling the powder composition and the sintering and annealing schedules. In order to avoid cracking in the pellet as a result of thermal stresses, slow heating rates are necessary. An alternatively method to alleviate the problem of long sintering times, and consequently low productivity, is the use of microwave energy in the sintering step. One of the many advantages attributed to microwave energy is that the heat is generated within the material itself and heating is thus volumetric in nature. Hence, through the use of microwave hybrid sintering, samples may be bought to the final temperature rapidly without the adverse thermal stress associated with conventional heating, and they are additionally predicted to contain a more uniform microstructure. This work has as aim the study of the microwave hybrid sintering of the ZnO-CuO varistor system. ZnO and CuO powders were mixed in an aqueous median by ball milling, freeze dried and then cold pressed into cylindrical samples of approximately 10 mm in diameter and 3 mm in thickness. The green samples were conventionally sintered with a heating rate of approximately 5^{o}C/mim and a soaking time of 30 and 60 mim. The complete sintering cycle (heating and cooling) varied from 400 to 500 mim. A 2.45 GHz microwave system, with silicon carbide as the susceptor agent, was used to the sintering of the samples. The heating cycle of the microwave sintering varied from 10 to 15 mim. After sintering electrical measurements were undertaken to the acquisition of the current-voltage behavior. The density of the samples was determined by the Archimedes method and the microstructure was analyzed by SEM. The microwave and conventional sintered samples have similar densities and microstructures. The breakdown fields and the non-linearity coefficient of the microwave and conventionally sintered samples were also similar, with values of approximately 50 and 654 V/mm respectively.