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A STUDY OF ELECTRICAL PROPERTIES OF Si-Al-O-N CERAMICS

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Sialons are "ceramic alloys" of Si3N4 and there are two important crystal structure types α and β with substitution of Al for Si and O for N in the network of SiN4 tetrahedra, based on αandβ Si3N4. These structures arise due to stacking of Si and N atomic layers in two different sequences. The presence of a continuous c- axis channel in the β- structure and the presence of two large interstitial sites in the α-structure are the consequences of these different sequences. The interstitial sites in the α-sialon structure suggest the ability of fabricating sialon ceramics with high electrical conductivity by doping suitable metal cations. This paper presents a study of the electrical conductivity and dielectric behaviour of some sialons in the temperature range 25°C-1150°C with different compositions. Pressureless sintered Ca, Y, Yb, Nd, Sm, and Er doped α-sialons with different α:β phase ratios and hot pressed Y, Ca doped α-sialons were used in this study.

An impedance analyser was employed to measure a.c. electrical conductivity. The sample was mounted in the sample holder and kept in a horizontal tube furnace. Two platinum plates were used as electrodes and platinum paste in-between the sample and the electrodes, was used to improve electrical contact. A.C. impedance data were collected in the temperature range 25°C-1150°C on heating and subsequent cooling by using the impedance analyser (4192 LF, HEWLETT PACKARD) in the frequency range 20 Hz –10 MHz. Transference numbers were determined in the same temperature range, by using the d. c. polarisation method. In this technique, a constant d. c. voltage was applied to the specimen and the current through a reference resister was monitored and recorded in a chart recorder as a function of time. Dielectric constant was calculated using the complex impedance data.

The study revealed that there was a significant dependence of electrical conductivity and dielectric property of sialons on temperature and composition. Yb-α-sialon showed the highest conductivity (1×10^{-7} S cm^{-1} at 25°C and 1×10^{-3} S cm^{-1} at 1150°C) with the lowest activation energy (0.3 eV) and slightly higher dielectric constant. The conductivity value of Yb-α-sialon is comparable with that of ZrO_2, which is used as a solid electrolyte. The other α-sialons showed lower conductivity and higher activation energy values than those of Yb-α-sialon. β-sialon also showed a lower value of conductivity (1×10^{-5} S cm^{-1} at 1000°C) than that of Yb-α-sialon. The existence of a mixed ionic-electronic conduction in Yb-α-sialon ceramics was evident from the d.c. polarisation tests. The similar conductivity values obtained in heating and cooling at a given temperature indicated that there were no compositional changes occurred during measurements.