

E1-01: Creep behaviour of hot isostatically pressed Si_3N_4 with different amounts of Y_2O_3 additives

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Silicon nitride (Si_3N_4), one of the best structural ceramics, has an extremely low self diffusivity due to its covalent nature of bonding. To obtain dense Si_3N_4 bodies, a sintering additive such as MgO is used. The additive reacts with free surface SiO_2 on Si_3N_4 particles and produces a silicate liquid at sintering temperature. This liquid phase promotes sintering and hence densification. However, on cooling, this liquid forms a residual glassy film at grain boundaries which softens at high temperatures, resulting in adverse effects on mechanical properties. With Y_2O_3 as a sintering additive, improved high temperature properties of Si_3N_4 can be obtained due to the formation of one or more highly refractory grain boundary phases.

In this study, creep properties of Hot Isostatically Pressed (HIPed) Si_3N_4 with 3.5, 4.0 and 7.5 wt% Y_2O_3 were investigated. All the materials selected were in the Si_3N_4 - $\text{Si}_2\text{N}_2\text{O}$ - $\text{Y}_2\text{Si}_2\text{O}_7$ compatibility triangle of the Si-Y-O-N system in order to minimise the oxidation. The material with 7.5 wt% Y_2O_3 was tailored to lie within the above triangle by adding 2.5 wt% SiO_2 .

Creep tests were conducted in an ambient air atmosphere at temperatures 1300°C and 1350°C in four point bending mode. All the materials investigated demonstrated excellent resistance to creep at these temperatures. The preliminary studies on the samples containing 3.5 wt% and 7.5 wt% Y_2O_3 showed linear stress dependence on creep rate. However, the material with 4 wt% Y_2O_3 cavitated during the creep deformation. This may be due to the variation of SiO_2 and impurity content in the starting material and differences in fabrication routes.