A STUDY OF CREEP BEHAVIOUR OF SOME α / β SIALON CERAMICS

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"Sialons" are a series of compounds resulting from the substitution of aluminium for silicon and, simultaneously, oxygen for nitrogen in the network of SiN_4 tetrahedra, based on α and β Si_3N_4. These structures arise due to the 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. Sialon is recognized as a potential ceramic material for structural applications due to its combination of many attractive properties such as superior high temperature strength, low thermal expansion, excellent thermal shock resistance, high fracture toughness and good oxidation resistance.

Creep, which is referred to as the time dependent deformation of a material at a constant stress, is an important factor to be considered in the design of structures and components that are subjected to stress at elevated temperature for long durations. As it becomes more suitable to use ceramics in high temperature applications, especially in heat engines, the understanding of creep deformation of ceramics becomes more important. In general, creep experiments on ceramic materials are often performed during bending to avoid the problems of gripping and buckling associated with tensile and compressive tests, respectively. For these reasons, a bending creep testing apparatus was designed to investigate the high temperature creep behaviour of bar shaped samples in 4-point bending mode.

In this study, the high temperature (1100 -1425 °C) creep behaviour of hot pressed Y and Ca α/β sialon with α : β phase ratio of 50:50 was investigated at different stress levels (25 -200 Pa). The tests were performed at both constant temperature and constant stress to identify the high temperature deformation mechanisms by determing. The creep parameters n (stress exponent) and Q (activation energy for creep). The specimens used in this study were in the form of rectangular bars with dimensions 3 mm x 3 mm x 35 mm.

The study revealed that the n value varies from 1.0 to 1.8 for Y- α/β sialon and in the case of Ca- α/β sialon, from 1.3 to 2.4 depending on the temperature and stress level. The non-integer stress exponents being greater than one (n>1) suggest that the creep deformation in these sialon ceramics is not purely due to diffusional processes (n=1), but may be due to a combination of diffusion and grain boundary sliding accommodated by cavitation. The activation energies for creep rate controlling process are 823 kJ/mol and 464 kJ/mol for Y-α/β sialon and Ca-α/β sialon respectively. These values are comparable with those for S_3N_4.