The Microstructural Characterization of SiAlON Ceramics after Creep

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One of the most widely studied engineering ceramics is Si_3N_4 as it provides a good combination of properties, suitable especially for high temperature applications. These properties include excellent fracture toughness, hardness, high strength, high temperature strength retention, creep and oxidation resistance [1]. Si_3N_4 can be further tailored for high temperature applications when aluminum and oxygen are substituted into the material to form SiAlON. SiAlON ceramics have the similar desirable properties as Si_3N_4, and offer more freedom for tailoring to specific applications through changes in composition and heat treatments [2]. As SiAlON ceramics are produced by liquid phase sintering, the additives usually remain in the microstructure after sintering as a secondary intergranular phase. The type and nature (whether its crystalline or not) of the intergranular phase, its melting temperature, viscosity and oxidation behavior are all important factors as these govern the high temperature properties of the SiAlONs [3].

In order to find out the role of the heat treatment on the creep resistance of SiAlON ceramics, the interfacial microstructure is investigated by using transmission electron microscope. The creep experiments for different samples were performed by four-point test under stresses from 50 to 150 MPa and at temperatures from 1300°C to 1400°C in air. For the electron microscopy investigations, as-received and crept samples were prepared by cutting, polishing, dimpling and finally ion beam thinning (Baltec RES 101). The prepared samples after coating (Baltec MED 020) with a thin carbon film were characterised by using 200 kV field emission transmission electron microscope (JEOL 2100F) attached with an energy filter (GATAN GIF TRIDIEM), paralel electron energy loss spectrometer (PEELS), a high angle annular dark field scanning transmission electron microscope (STEM-HAADF) detector and an energy dispersive x-ray (EDX) spectrometer (JEOL JED-2300T).

TEM images of as-received and heat treated samples are shown in Figure 1. It can be seen that after heat treatment the crystallization is increased. When the creep behavior of as-received and heat treated samples are compared, at all creep temperatures carried out in this study, heat-treated α-β SiAlON composite showed better creep resistance and significant decrease in strain rate. And this difference is due to the crystallization of intergranular glassy phases as demonstrated by TEM analysis shown Figure 1. The STEM and TEM analysis of crept sample showed cavitations at triple junctions as shown in Figure 2.

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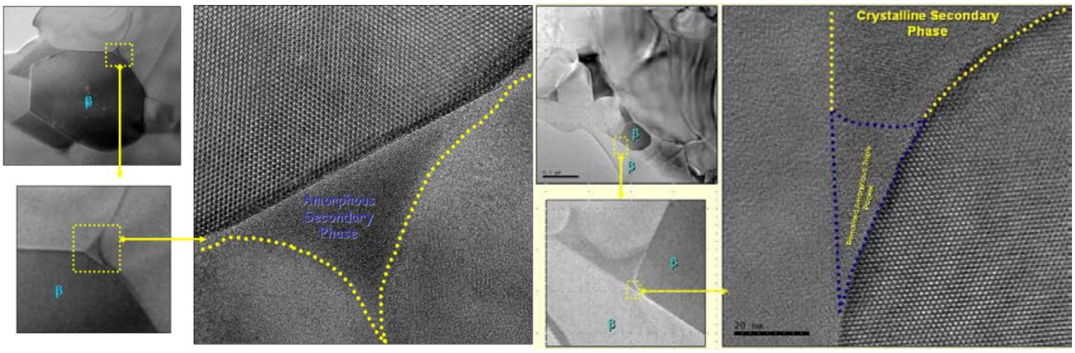
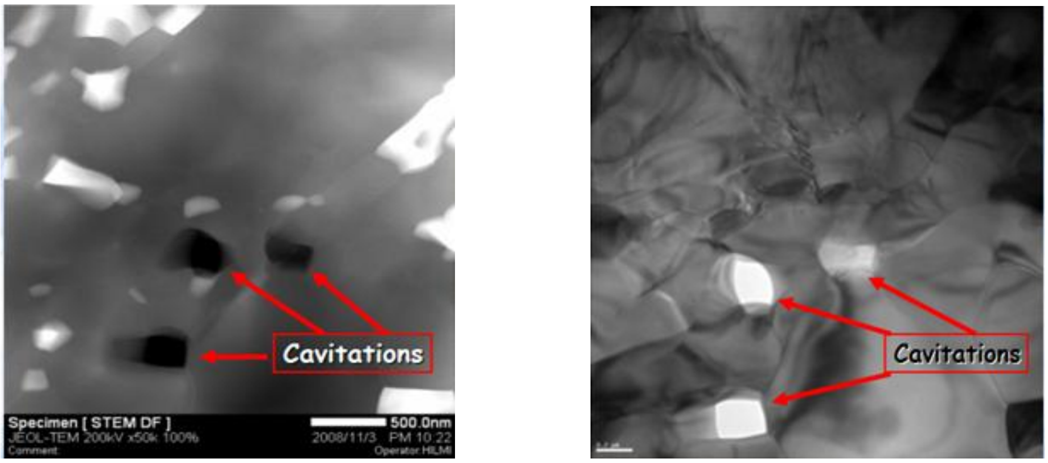


(a) (b)

Figure 1. TEM images of (a) as-received SiAlON and (b) after heat treatment showing a better triple junction crystallinity



(a) (b)

Figure 2. STEM-HAADF (a) and BF TEM (b) images of heat treated and crept SiAlON ceramic showing cavitations occurred as a result of creep deformation

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