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Cavity Formation Study in SiC/SiC Composite Irradiated with Multiple-ion Beam at Elevated Temperatures

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Silicon carbide fiber-reinforced Silicon carbide composites are the major candidates as the advanced structural materials for the future fusion power reactor due to its low induced radioactivity, high specific strength, and high temperature strength. One of the main concerns to use these materials in the fusion environment is the radiation stability of the microstructures in advanced SiC/SiC composites which in turn will affect their high temperature mechanical strength. In this study, we irradiated two types SiC/SiC composites made with advanced SiC fibers namely, Tyranno-SA and Hi-Nicalon Type-S, respectively, by using dual-ion beam (6 MeV Si^{3+} and 1.13 MeV He^{+}) at a dose rate of $4x10^{-6}$ dpa/s and 150 appm He/dpa. The experiments were performed at elevated temperatures (600°C~1000°C) and under high vacuum ($1x\ 10^{-7}$ Torr). The microstructure analysis is done by transmission electron microscopy.

In the experiment of 10dpa at 600°C, there was no cavity or bubble found in both materials: Tyranno-SA/SiC and Hi-Nicalon Type-S/SiC. In the experiment of 100dpa at 800°C, we found bubbles in the SiC matrix of both composites, (fig. 1) and also in the fiber of Tyranno-SA/SiC, (fig. 2) but not in the fiber of Hi-Nicalon Type-S/SiC. It is believed that due to the grain size of Hi-Nicalon Type-S is much smaller than that of Tyranno-SA. In the experiment of 100dpa at 1000°C, bubbles in the matrix of Tyranno-SA/SiC and Hi-Nicalon Type-S/SiC, (fig. 3) and the fiber of Tyranno-SA and Hi-Nicalon Type-S (fig. 4) were found.

We have completed the triple beam irradiation system recently. The experiment of dual-beam irradiation (15000appm He^{+} and 6000appm H^{+} ions) at elevated temperatures (800°C~1000°C) and triple-beam irradiation (150 appm He/dpa and 60appm H/dpa) at 800°C are underway and we will report more results in the symposium.

Reference

[1] L.L. Snead et al., J. Nucl. Mater. 233–237 (1996) 26.
[2] A. Hasegawa et al., J. Nucl. Mater. 283–287 (2000) 128.

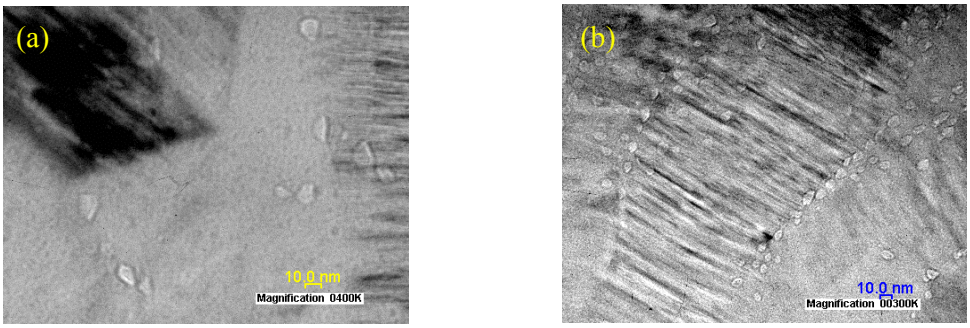

Fig.1 (a) bubbles in matrix of Tyranno-SA
(b)bubbles in matrix of Hi-Nicalon Type-S

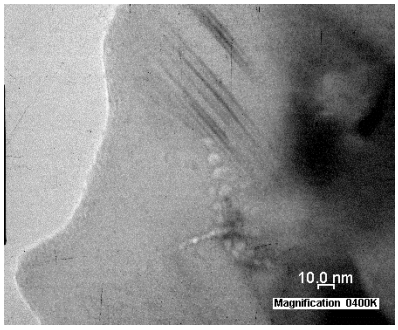

Fig.2. bubbles in fiber of Tyranno-SA

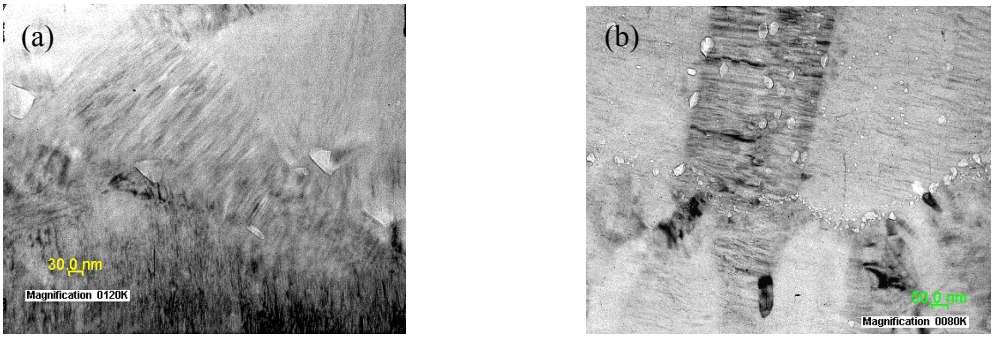

Fig.3 (a) bubbles in matrix of Tyranno-SA
(b)bubbles in matrix of Hi-Nicalon Type-S

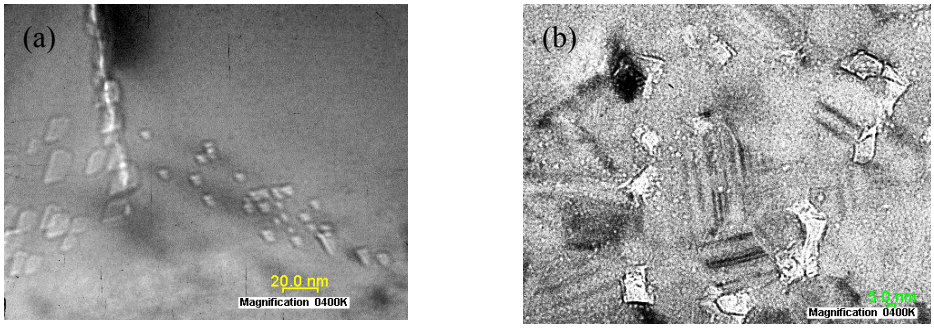

Fig.4 (a) bubbles in fiber of Tyranno-SA
(b)bubbles in fiber of Hi-Nicalon Type-S

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