Response of C/BN Particle Dispersed SiC Materials to Ion Irradiation

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Abstract

The precise control and weakness against environmental corrosion of the fiber/matrix interphase are bothering the SiC composite industry. To overcome these problems, the C/BN particle dispersed SiC composites without interphase have been developed and displayed promising prospect in nuclear applications. Here in this study the ion irradiation response of C/BN particle dispersed SiC materials will be firstly reported.

Keywords: Silicon carbide, C/BN particle, Ion irradiation, Swelling, Microstructure

1. Introduction

Basically weak fiber/matrix interphase such as carbon (C) or boron nitride (BN) is required for SiC_f/SiC composites. Precise control of the interphase material, however, is a critical issue in terms of large scale production and material cost. In addition, the interphase is the weakest point for the environmental effects. To overcome these problems, the C/BN particle dispersed SiC composites without interphase have been developed and displayed promising mechanical properties and oxidation resistance [1]. As other critical property for nuclear application, the irradiation response of C/BN particle dispersed SiC materials will be explored and reported here.

2. Experiments

SiC-20vol% BN and SiC-20vol% C matrixes were fabricated by liquid-phase sintering using hot press for consolidation. CVD SiC was used for comparison. These samples were polished to be mirror-like and then irradiated to 0.1/1/3 dpa by 5.1 MeV Si^{2+} ions in the DuET facility, Kyoto University. The surface morphology was observed by AFM and the swelling induced by irradiation was calculated from the AFM data. Hardness and elastic modulus were obtained by nanoindentation tests and the microstructure was observed by TEM.

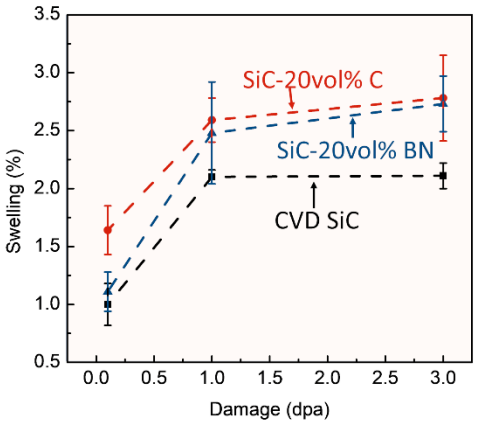

Fig. 1. Swelling after ion irradiation.

3. Results

The swelling of CVD SiC saturates at 1 dpa, to a value of ~2.1%, while the swelling of SiC-20vol% BN shows a larger swelling than CVD SiC at the three investigated damage levels and increases from 2.48 ± 0.44 % at 1 dpa to 2.73 ± 0.24 % at 3 dpa. The swelling of SiC-20vol% C shows a similar trend to that of SiC-20vol% BN, although the values are slightly larger. SiC-20vol% C, with the original hardness of 14.13 ± 3 GPa to hardness of 21.35 ± 4.02 GPa after damage of 3 dpa, also shows more severe irradiation hardening than SiC-20vol% BN (original 19.04 ± 2.22 GPa to 21.71 ± 3.37 GPa after damage of 3 dpa). More details will be given in the later full report.

4. Conclusion

After irradiation, the liquid-phase-sintered SiC-20vol% BN and SiC-20vol% C matrixes show similar trend of swelling and hardening to CVD SiC, although the values are slightly larger.

References

[1] Tatsuya Hinoki, Kanjiro Kawasaki, Fujio Shinoda, and Kazuya Shimoda, "High temperature mechanical properties of BN particle dispersion SiC composites" in "Composites at Lake Louise 2017", ECI Symposium Series, (2017).