

IN-SITU OBSERVATION AND Multi-PHYSICS SIMULATION OF REACTIVE MELT INFILTRATION OF SILICON MELT INTO SiC-C PREFORM

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Reactive silicon melt infiltration method is one of the high-speed production methods for SiC fiber-reinforced SiC matrix composites. In the process, it is necessary to suppress fiber deterioration due to excessive temperature increase caused by the formation heat of SiC during silicon infiltration into the SiC-C preform in which SiC fibers are aligned and to increase the infiltration velocity. Therefore, in order to efficiently develop the melt infiltration technology, we conducted the in-situ observation of the infiltration of silicon melt into the SiC-C preform and the development of an infiltration simulator based on the multi-physics based on the observation.

In the in-situ observation, the test material was a SiC-C preform in which SiC powder, carbon powder and SiC fibers are bonded with resin and calcined by heating at 600 °C in an Ar atmosphere. A preform of 2 × 5 mm was placed in an infrared heating furnace, and the infiltration process of silicon melt was in-situ observed using an optical microscope. The silicon droplet was melted on the BN substrate at a temperature 20-100 K higher than its melting point, and the preform was contacted with the short side of preform to start melt infiltration. Figure 1 is the example of the observation, and shows the infiltration when silicon is infiltration in the parallel and vertical directions of the fibers uni-directionally aligned in the preform. Infiltration proceeded along the fiber when infiltrating in the direction parallel to the aligned fibers whereas it proceeded by repeatedly advancing across the fiber in the case of infiltrating in the vertical direction to the aligned fibers. The infiltration velocity in the direction parallel to the fiber is around twice as high as that in the vertical direction. It has also been observed that the infiltration occurred at the constant velocity for the preforms of this size.

In addition, using the finite element software COMSOL Multiphysics 5.3, an infiltration simulator has been built, where the material fraction of the preform is input, and the silicon infiltration process attributed to its reaction property and the reaction heat generation between infiltrated silicon and carbon materials in preform are considered. The details of the simulator will be explained in the presentation.

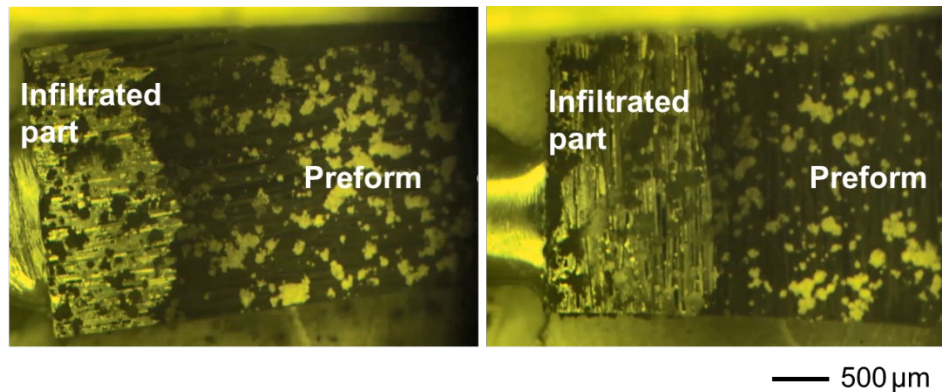


Figure 1 – Infiltration of molten silicon into the preforms with SiC fibers parallel (left) and vertical (right) to infiltration direction at the superheat of 100K.