HIGH TEMPERATURE REPEATED LOADING-UNLOADING TEST IN SIC/SIC USING NEW-THREE-ZONE TYPE EQUIPMENT

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In today's aircraft industry, the reduction of CO_2 emissions from aircraft and the conservation of fossil resources consumed as fuel are urgent issues. As measures to solve these problems, research is being conducted to improve the mechanical properties of structural materials to reduce aircraft weight and increase the fuel efficiency of jet engines. One of these is the application of SiC/SiC ceramics matrix composites (SiC/SiC CMC), in which SiC ceramics are reinforced with SiC fibers, to the hot sections of aircraft jet engines. The aim of this research is to clarify the tensile loading-unloading behaviors of SiC/SiC CMC at room and high temperatures, and to examine a high temperature mechanical testing method using a new type equipment.

In this research, experiments were conducted using a new high-temperature mechanical testing machine (MTS Landmark with 3 zone type furnace) that was developed to improve the process of specimen heating, which has been an issue with conventional mechanical testing machine in conducting high-temperature mechanical test of SiC/SiC CMC. By heating not only the specimen but also the grips used to fix the specimen together, this testing machine provides advantages such as higher heat uniformity, faster temperature rise, and smaller specimen size (lower cost). High temperature extensometer was used to measure axial strain by contacting SiC extension rods that extended into the furnace. The composites used in this research were processed by chemical vapor infiltration (CVI) of SiC/SiC. The tensile loading-unloading tests were performed at room temperature and 1273K in air. After fracture the specimens were examined by scanning electron microscopy (SEM) for estimate mechanical damage and chemical changes that occur inside the specimens. For the tensile loading-unloading test, the specimens were heated at 40K/min to complete the heating process within 30 minutes and the mechanical test was conducted at a rate of 5mm/min so that the specimens were ruptured within 10 seconds, in accordance with ASTM standard C1359-13.

For the tensile loading-unloading test at room temperature, the breaking stress was 208MPa and the maximum strain was 0,0032mm/mm. At 1273K, the breaking stress was 232MPa and the maximum strain was 0.0048mm/mm. The results indicate that internal damage to the specimens reduced their unloading modulus and made them more susceptible to deformation. The properties of SiC/SiC CMC at high temperatures were found to be high relative to room temperature due to damage tolerant mechanism.

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