§94. Evaluation of Interfacial Shear Strength of SiC/SiC Composites by Micro-Indentation Technique

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Ceramic matrix composites (CMCs) are considered to be promising and potential materials durable under severe environments represented by future fusion devices. In addition to the many advantages of carbon and/or silicon carbide composites, SiC/SiC composites' low induced activation characteristics under neutron and high energy particle irradiation make them very attractive as materials of fusion structures.

The importance of fiber-matrix interfacial shear strength on mechanical properties of CMCs has long been emphasized, however, a clear understanding of this relation has not been established nor even provided yet. In order to quantitatively evaluate interfacial mechanical properties, pull-out, push-out, protrusion, and multiple fracture tests had been applied to CMCs and a variety of results have been published. One of the important accomplishments made in these years is the work done by Oak Ridge National Laboratory group as the part of DOE CFCC program where the International Test System was developed and utilized. Still, they have not been quite successful to quantitatively clarify the role of interfacial shear strength on mechanical properties of composites. The authors' group has been concentrating its efforts in utilizing the micro-indentation technique on UD and 2D fiber reinforced composites, such as C/C and SiC/SiC.

The objective of this work is to establish the basis to evaluate interfacial shear strength in SiC/SiC composites and to correlate the property with other mechanical properties of the composites. Indentation load vs. indentor displacement relations obtained from the fiber push-out test were investigated and deformation and fracture behavior of CMC was analyzed to define the interfacial shear strength in CMC. The relationship between bending strength and interfacial shear strength of SiC(pcs)/SiC(CVI) is preliminary postulated together with the crack initiation and propagation characteristics and micro-structural characteristics of the composites.

The preliminary results of the present work are summarized:

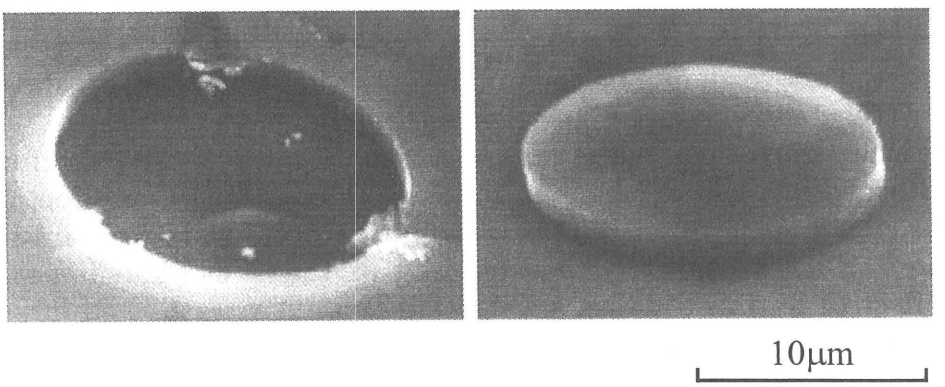
(1) With an adequate carbon coating on the SiC fibers, cracks initiated in the fibers and in the matrix, in general, stayed within the original area and crack propagation across the fiber-matrix interface was quite scarce.

(2) From the indentation load vs. displacement curves, loads for interfacial debond-initiation and interfacial sliding were obtained. A definition of interfacial shear strength as obtained from the push-out test is given.

(3) With a carbon coating thickness greater than 500 nm, a significant modification in interface contributes mechanical properties of SiC composites, was observed.

(4) The large scatter in the values of interfacial shear strength and bend strength requires further work.

The following pair of micrographs shows the example of appearance of SiC fiber displaced by micro-indenter.



SEM micrographs of SiC fibers (Hi-Nicalon) observed from push-in and push-out specimen surfaces.