POSTER

A PRELIMINARY INVESTIGATION ON QUANTITATIVE EVALUATION OF THE INTERFACIAL BOND PROPERTIES IN C/C COMPOSITES

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INTRODUCTION

The interfacial bonding property of C/C composite is closely correlated to the material processing parameters and its macroscopic mechanical properties. Up to now, however, no direct method for quantitatively measuring the interfacial bonding strength between carbon fiber and carbon matrix is available. Scanning electron microscopy, transmission microscopy and micrography may provide excellent information about the interfacical bond status and the fractography of C/C composites, but can not reflect any information on the interfacial strength data. This paper presents some preliminary results of quantitative research in the interfacial properties of C/C composites, by using the recently developed technique [1] of interfacial strength in situ microdebonding test.

EXPERIMENTAL

The materials used in this paper were two fine weave pierced C/C composites with the same processing technology (impregnating pitch under high pressure, the same texture parameters and volume desity of 2. 0 g/cm^3). Specimen for microdebonding test was prepared by cutting a small piece (typically 5mm×5mm×3mm) from the C/C composites, perpendicularly to Z-axial fiber bundles. Polishing of the cutting surface was by conventional metallographic techniques. The in situ interfacial strength microdebonding test instrument [2] (model HIT-100) was used to measure the interfacial microdebonding force between single fiber along Z-axis and its surrounding matrix. In the test a compressive load was applied axially to the end of a single fiber until interfacial microdebonding occured. Recorded by computer, the load at debond was input to a finite-element program, which calculates the interfacial shear strength.

RESULTS AND DISCUSSION

Table 1 lists the testing results of the interfacial properties of interiors and peripheries of Z-axial fiber bundles at different regions in C/C composites. The interfacial appearances after microdebonding test are shown in Figure 1. From Table 1, it is shown that.

1. The interfacial bonding properties of interiors of differently regional Z-axial fiber bundles are similar for certain composite.
2. The interfacial bonding properties of peripheries of different regional Z-axial fiber bundles are similar for certian composite.
3. The interfacial strength at peripheral region is less than that at interior region in Z-axial fiber bundles for certain composites.
4. The interfacial properties and macroscopic mechanical performances are different in composites with the same processing technique, but the quantitative relationship between them has not been found.

The results of various aspects of macroscopic properties at different regions of # 1 composite show that these macroscopic property discrepancies are rather small among its different regions. This is consistent with the finding "different regions, similar interfacial properties". Consequently, it indicates that the whole composite interfacial properties can be reflected by the local interfacial property testing results.

The fact that peripheral interfacial properties are inferior to interior ones in fiber bundles may bear relation with the structural characteristics of the fine weave pierced C/C composites and also with the selected processing technology. It is well known that C/C composites are manufactured via repeated working procedures of pitch impregnation, impregnation under high pressure, carbonization and graphitization. And its carbon matrix at different regions is formed during different working procedures mentioned above. The cabon matrix, made from the impregnatd pitch during the early procedures, exists in space between interior fibers of a fiber bundle, but the matrix in the larger spaces between Z-axial fiber bundle and XY plane carbon cloth is relatively less. With the densification of the composite, in addition to continually densification fiber bundles, carbon matrix gradually permeates around Z-axial fiber bundles and forms high density C/C composites finally. The difference between formation mechanisms of carbon matrix in the interior and periphery of Z-axial fiber bondles, perhaps results in the discrepancy of interfacaial properties between the interior and the periphery of fiber bundles.

Since composite production requires long producing cycling and many working procedures, and there might be variations in processing technology parameter of different batched C/C composites, all of which result in the fluctuation of macroscopic and interfacial properties. Using the interfacial microdebonding technique to measure the interfacial properties of C/C finished and semi-finished products and to quantitatively study the relations among the C/C composite processing technology, the interfacial properties and the macroscopic properties, we may find the crucial working procedure affecting composite interfacial properties and also obtain the optimal interfacial property values in order to stablize and improve product quality. All of these are most important aspects of the application of the interfacial microdebonding technique in C/C composite research, and correspondingly cannot be substituted by other interfacial research techniques.

CONCLUSIONS

1. Interfacial properties are different between inside and periphery of a fiber bundle in fine weave pierced C/C composites.
2. There may be difference in interfacial properties in C/C composites despite being manufactured by the same processing technology.
3. The interfacial microdebonding technique can be used to quantitatively measure the interfacial bonding strength of C/C composites.

REFERENCES

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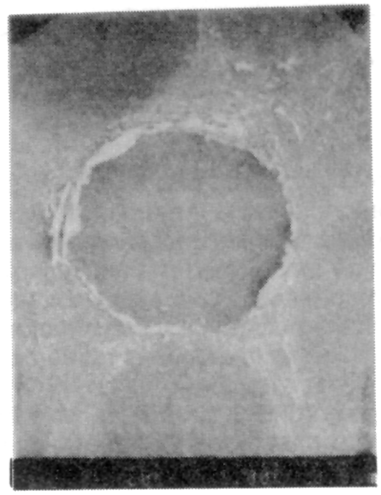

Figure 1-SEM photograph of C/C composite: center fiber after debonding

TABLE 1-Physical Test results of C/C Composites

		Region 1			Region 2			Macroscopic Tensile Strength (MPa)
		Fdeb. (mN)		ISS(MPa)	Fdeb. (mN)		ISS(MPa)	
		F(0°)	F(100°)	τ	F(0°)	F(100°)	τ	σ_τ
1#	IB	15	29	58.5	16	30	60.2	170
	PB	10	23	38.6	11	23	41.0	
2#	IB	9	19	36.3	10	17	37.9	157
	PB	7	12	28.5	5	10	22.4	

0°: Initial debond
100°: Initial completed debond
ISS: Interfacial Shear Strength
Fdeb.: Debonding Force
IB: Interior of fiber bundle
PB: Periphery of fiber bundle