MINIMUM BAR SIZE FOR FLEXURE TESTING OF IRRADIATED SIC/SIC COMPOSITE -
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OBJECTIVE

The objective of this work is to examine current practice for comparing the mechanical and thermal properties of irradiated, continuous SiC fiber/SiC matrix composites (SiC/SiC) and to recommend consistent and sensible test methodologies within the constraints of limited reactor test volumes.

SUMMARY

This report covers material presented at the IEA/Jupiter Joint International Workshop on SiC/SiC Composites for Fusion Structural Applications held in conjunction with ICFRM-8, Sendai, Japan, Oct. 23-24, 1997. The minimum bar size for 4-point flexure testing of SiC/SiC composite recommended by PNNL for irradiation effects studies is 30 x 6 x 2 mm^3 with a span-to-depth ratio of 10/1 .

PROGRESS AND STATUS

Introduction

This report updates the recommendations and rationale for the minimum bar size for 4-point flexure testing of irradiated SiC/SiC composite previously presented [1]. Because the specimen volume and number likely will be limited in reactor exposures, the minimum conditions recommended by PNNL for SiC/SiC fusion structural material development are less than ASTM recommendations for non-fusion applications. The PNNL and ASTM subcommittee C28.07 recommendations [2] are compared in Table 1.

Table 1. Comparison of conditions for 4-Pt. flexure testing of SiC/SiC.

Category	ASTM Subcommittee C28.07	Fusion PNNL Recommended
No. of Samples	10	5
Minimum Size (Lxbxd mm^3)	45 x 6 x 2	30 x 6 x 2
Span-to-Depth** (S/d)	16/1 to 30 /1	10/1
Bar Width	2 x repeat cell distance	4 bundle widths
Overhang (mm)	5+	5
Surface Finish	Varied	Tensile Surface unfinished
Strain Rate (sec^{-1})	10^{-3}	10^{-3}

** Increase S/d t reduce potential for premature interlaminar shear failure.

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To reduce irradiated specimen total volume, the ASTM recommended minimum number of samples is reduced from 10 to 5, the bar length from 45 to 30 mm, and the span-to-depth ratio (S/d) from 16/1 to 10/1. For a valid flexure test, the bar must initially fracture at the tensile surface. Since interlaminar shear failures are more likely when the specimen S/d ratio is 10/1, careful examination of the stress-strain curves and the failed bars must be carried out to eliminate invalid tests. To reduce somewhat the potential for shear failure, the minimum bar width and the unstressed overhang are retained at ≈6 mm and 5 mm, respectively. If the bar thickness must be reduced to attain a S/d = 10, the specimen should be machined from the compressive surface only.

As examples of invalid SiC/SiC flexure tests, in Figure 1 several failed bend bars illustrate premature failure by (a) delamination from the ends or (b) at a surface where the reinforcing fibers were preferentially cut through by surface machining along the aligned fabric weave ridges.

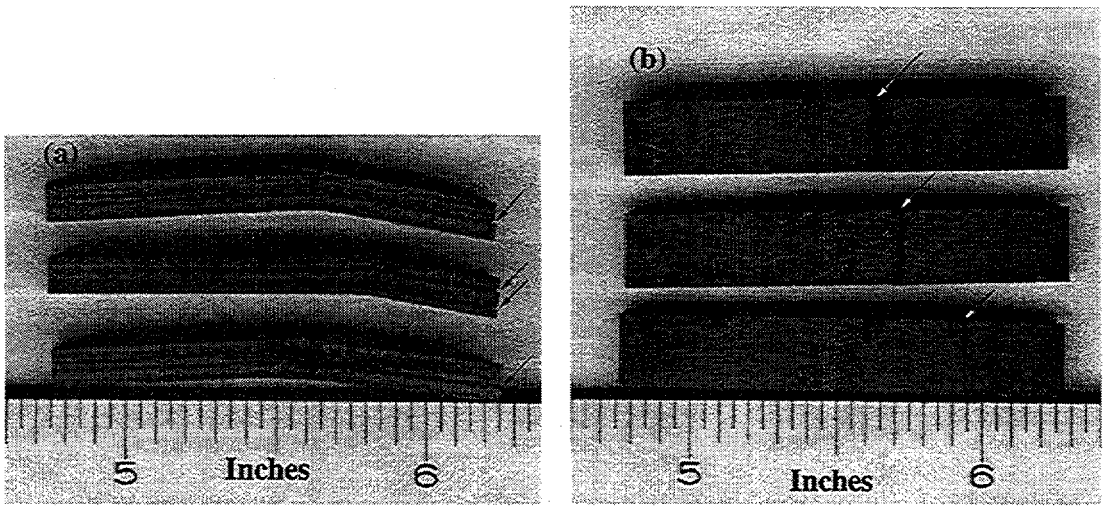

Figure 1. Illustration of invalid SiC/SiC flexure tests. (a) Edge view of bend bars showing delamination from the ends and (b) tensile surface of bend bars showing premature failure due to cutting through aligned woven fibers at the tensile surface.

FUTURE WORK

A size effect analysis for flexure bars (30 x 6 x 2 mm^3) will be carried out on a reference Hi Nicalon SiC/SiC composite scheduled for irradiation as part of the Jupiter P3-4 tests.

REFERENCES

1. G. E. Youngblood, C. H. Henager, Jr., and R. H. Jones, "Specimen Size Effect Considerations for Irradiation Studies of SiC/SiC," Fusion Materials Semiannual Progress Report for Period Ending June 30, 1996. DOE/ER--0313/20.

2. "Standard Test Method for Flexural Properties of Continuous Fiber-Reinforced Advanced Ceramics Composites - ASTM Draft 1.7," 24 February 1996.