Dynamic Small Strain Measurements of Kevlar® 129 Single Fibers with a Miniaturized Tension Kolsky Bar

Jaeyoung Lim[a], Weinong W Chen[a]

[a] *Schools of Aeronautics/Astronautics and Materials Engineering*

Purdue University, West Lafayette, IN 47907

ABSTRACT

We adopted a non-contact laser technique to measure axial small strain (<~5%) of Kevlar® 129 fibers in a miniaturized tension Kolsky bar. Dynamic strain measurement was made via a high-speed photodetector at very high resolution. Tensile experimental results at a constant strain rate of ~1500/s demonstrate the capability of the non-contact laser technique combined in a modified Kolsky bar to determine the tensile stress-strain behavior of high-performance single fibers with small strain.

1. INTRODUCTION

The small strain measurement is important in relatively brittle materials such as ceramic and high performance fibers as well as in ductile metal. A modified Kolsky tension bar for single fiber tests, first introduced by Cheng et al., has been developed by Lim et al. [1] to determine the tensile response of single fibers at high rates. In this article, we adopted a non-contact laser technique for axial small strain (<~5%) measurements of Kevlar® 129 single fibers under high strain rate loading, together with a miniaturized tension Kolsky bar. Some experimental results of Kevlar® 129 single fibers at a constant strain rate of ~1500/s are presented.

2. EXPERIMENTAL ARRANGEMENT

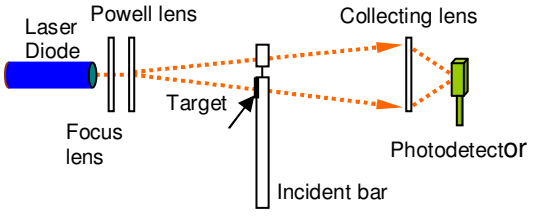

Fig. 1 Experimental setup for small strain measurement

We adopted a non-contact laser technique to measure axial small strain (<~5%) during the deformation of the fiber. This system can be built on the optical table for ease of alignment, together with a miniaturized tension Kolsky bar. The complete optical arrangement is indicated in Fig. 1.

3. RESULTS

High-rate tensile tests are performed at a constant strain rate of ~1500/s. As shown in Fig. 2, the single Kevlar® 129 fibers represent a very linear stress-strain relationship up to the point of failure. The ultimate strength and failure strain of Kevlar® 129 fiber are 4.64±0.10GPa and 4.72±0.36%, respectively.

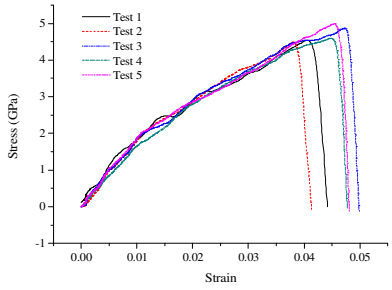

Fig. 2 Dynamic stress strain curves of Kevlar® 129

4. CONCLUSIONS

We have adopted a non-contact laser technique, together with a miniaturized tension Kolsky bar, to measure axial small strain (<~5%) of Kevlar® 129 single fibers with highly orient polymer chain. Using this optical arrangement, we can measure the accurate failure strains under dynamic tensile loading.

REFERENCES

1. J. Lim, J.Q. Zheng, K. Masters, W. Chen, Mechanical Behavior of A265 Single Fibers, Journal of Materials Science, 45, (2010), 652-661.