MOISTURE UPTAKE IN HIGH PERFORMANCE FIBERS

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INTRODUCTION

Objective: Develop a method to determine the amount of water absorbed by high performance fibers during conditioning experiments for fibers submerged in water.

High performance aramid fibers are an important component of many civilian and military applications; however, their degradation is not well understood.

The amount of water absorbed is an indication of the degradation of strength.

BACKGROUND

As thermodynamically metastable materials, these fibers can be very sensitive to changes in surrounding environmental conditions.

With hygrothermal conditioning at temperatures above 80°C for 34 days, the tensile properties of fibers degrade from 13-58% as compared to dried-as-received fibers, depending on the type.

KEVLAR RESULTS

12.9% Bound Water

ARMOS RESULTS

6.60% Bound Water

CHALLENGES

- Water bound to the surface of the fiber will not affect fiber strength like moisture that has diffused into the fiber interior.
- It is difficult to differentiate free water on the surface from bound water with a traditional balance.

CONCLUSIONS

- It is conceivable that the differing chemical structure and microstructure of Kevlar and Armos account for the different amounts of water uptake.
- Kevlar has a larger concentration of hydrophilic amide groups than the copolymer Armos.
- Armos has a liquid crystalline microstructure that is more damage resistant.
- The TGA/DSC1 has so far provided a reliable and precise method of monitoring mass loss in high performance fibers at a constant temperature but further refinement is needed.
- Analysis of the heat flow curve can provide more information to define the boundary between free and bound water.

FUTURE WORK

- The heat of evaporation of water can be calculated by dividing the heat flow by the mass loss derivative (mW/(mg/sec) = J/g); bound water should have a higher heat of evaporation.
- Comparisons for fibers conditioned at different temperatures for different periods of time.

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