**Strength and Fatigue of Glass Fibers**

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**Overview**

- Our research goal is to characterize the strength and fatigue behavior of different glasses and relate that behavior to differences in the glass structure. In this study, we describe experiments performed on fibers drawn from silicate and phosphate glass melts.

- The effects of composition and structure on glass strength are difficult to quantify because of the presence of strength-limiting defects and the lack of a well-defined boundary between the matrix and the surface. To determine these differences in the glass structures, we describe how to measure the fatigue characteristics of our glasses. Fibers are fractured at room temperature in atmospheres with different relative humidities and at different strain rates.

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**Glass Compositions**

- Various compositions are used to study the impact of different glass types on fatigue behavior.

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**Fiber Strength Measurements**

- **Two-Point Bend Experiments**
  - Break strength fibers fractured in LN for inert strength.
  - Fresh fibers fractured in air at various RH for inert and dynamic fatigue.
  - Fresh fibers fractured at various strain rates to determine dynamic fatigue effects.

- **Wheel Drawing Produces High Strength and Tight Distributions**
  - Wheel drawing produces high-strength fibers with consistent and uniform characteristics.

- **Inert Fiber Strengths**
  - Phosphate and silicate fibers are broken in liquid nitrogen to obtain the most strength measurements.

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**Fatigue Experiment #1 – Varying Humidity**

Strength measurements made on newly pulled E-Glass performed in a glove box to control humidity. E-Glass strength decreases with increased humidity.

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**Fatigue Experiment #2 - Strain Rate Dependence**

E-Glass strength decreases with decreasing strain rates and decreasing humidity.

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**Fatigue Experiment #3 - Strain Rate Dependence**

Phosphate glasses do not exhibit the same fatigue characteristics as silicate. Higher humidity leads to lower strength, but strain does not depend on strain rate.

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**Dynamic Fatigue Dependence**

The fracture strength dependence on face plate velocity provides the fatigue parameter, n.

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**Phosphate Glass Strain Rate Dependence**

Phosphate glasses do not exhibit the same fatigue characteristics as silicate. Higher humidity leads to lower strength, but strain does not depend on strain rate.

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**Summary**

- We have developed techniques to obtain good strength distributions for glass fibers.
- We have characterized effects of humidity on strength.
- We have characterized fatigue behavior.
- Future work: How does composition affect strength and dynamic fatigue?
- Why are phosphate glasses not dependent on strain rates but are dependent on relative humidity?

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**Elastic Modulus Measurements**

Elastic modulus (E) is determined by an ultrasonic technique that measures both longitudinal (V L ) and transverse wave velocities (V T ).