# Hollow Core Fiber Tensile Tester

is an important experimental laser component that is hand assembled due to the fragile nature of the fiber glass material and should be able to be repeatable for future experiments.

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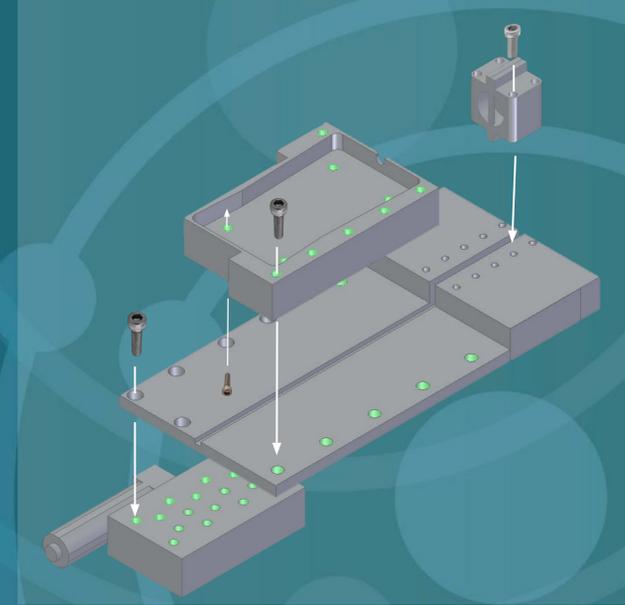
Design Limitations

- Visibility of the stage dial numbers is necessary in order to measure length change
- Hole locations of the micrometer stage and force gauge
- 25 vs 50 N gauge use determined by:

  $$F = UTS \times A$$

- Component and fiberglass strength
- Fixed length of the force gauge hook
- Understanding 3D printer maximum capabilities of creating a decent model

Calculations

Assume :

  outer radius (mm) : 0.176

  inner radius (mm) : 0.099

  measured force (N) : 4

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Cross Sectional Area :

$$= \pi(0.000176 \text{ m})^2 - \pi(0.000099 \text{m})^2$$

$$= 6.7 \times 10^{-8} \text{ m}^2$$

Ultimate Tensile Strength :

$$= 4 \text{ N} / (6.7 \times 10^{-8} \text{ m}^2)$$

$$= 6 \times 10^7 \text{ Pa}$$

Strain ε :

$$= 0.04 \times 10^{-6}$$

$$= 4 \times 10^{-8}$$

Displacement Change :

$$= (4 \times 10^{-8})20 \text{ cm}$$

$$= 8 \times 10^{-7} \text{ cm}$$

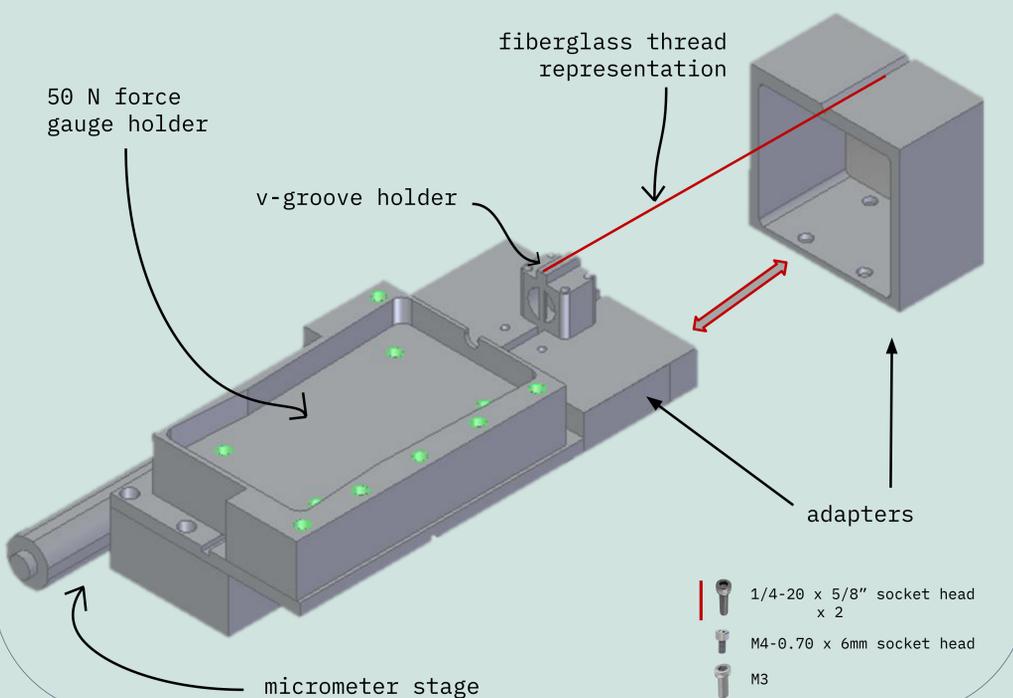$$= 0.008 \text{ μm}$$

Stress σ :

$$= 4 \text{ N} / (6.7 \times 10^{-8} \text{ m}^2)$$

$$= 6 \times 10^7 \text{ Pa}$$

Test Assembly

Final Design

left assembly 81.9x58.1 mm

right part 65x60.5 mm

50 N force gauge holder

fiberglass thread representation

v-groove holder

adapters

micrometer stage

1/4-20 x 5/8" socket head x 2

M4-0.70 x 6mm socket head

M3

Theoretical Results

- Straight positive angled line and then drop after reaching the ultimate tensile strength
  - Sudden fall due to the stiffness of fiberglass
- Less force will be needed to break compared to normal fiber due to less affected area
- Size ratio (not including dial) ~ 1.31:1
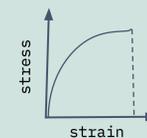
stress

strain

Future Plans

- Refine design
- Stretch fibers and do manual testing
- Calculate stress and strain with the following formulas

$$\sigma = F / A$$

$$= F / (\pi r_{outer}^2 - \pi r_{inner}^2)$$

$$\varepsilon = \triangle L / L_0$$

REFERENCES   Chuck design by John C. Travers and stretch chuck holder design by Chris Brahms were referenced during the design process for the v-groove holder and adapters.