

Denim Fabric as Heat Protection

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2.671 Measurement and Instrumentation



Abstract

Fire-spinners often wear denim fabric to protect against accidental contact with a burning prop. How much protection do different fabrics actually afford? A heat source was applied to several samples of common cotton denim fabric in five different thicknesses, and temperature was measured across the fabric. For each experiment, the time taken for the far side of the fabric to reach a normalized temperature of 60° C was recorded. A strong correlation was found between increased fabric thickness and increased time of protection. Additionally, even the thinnest fabric was able to offer 5.2 ± 1.2 seconds of protection from 100° C heat.

Setup

Diagram of Setup

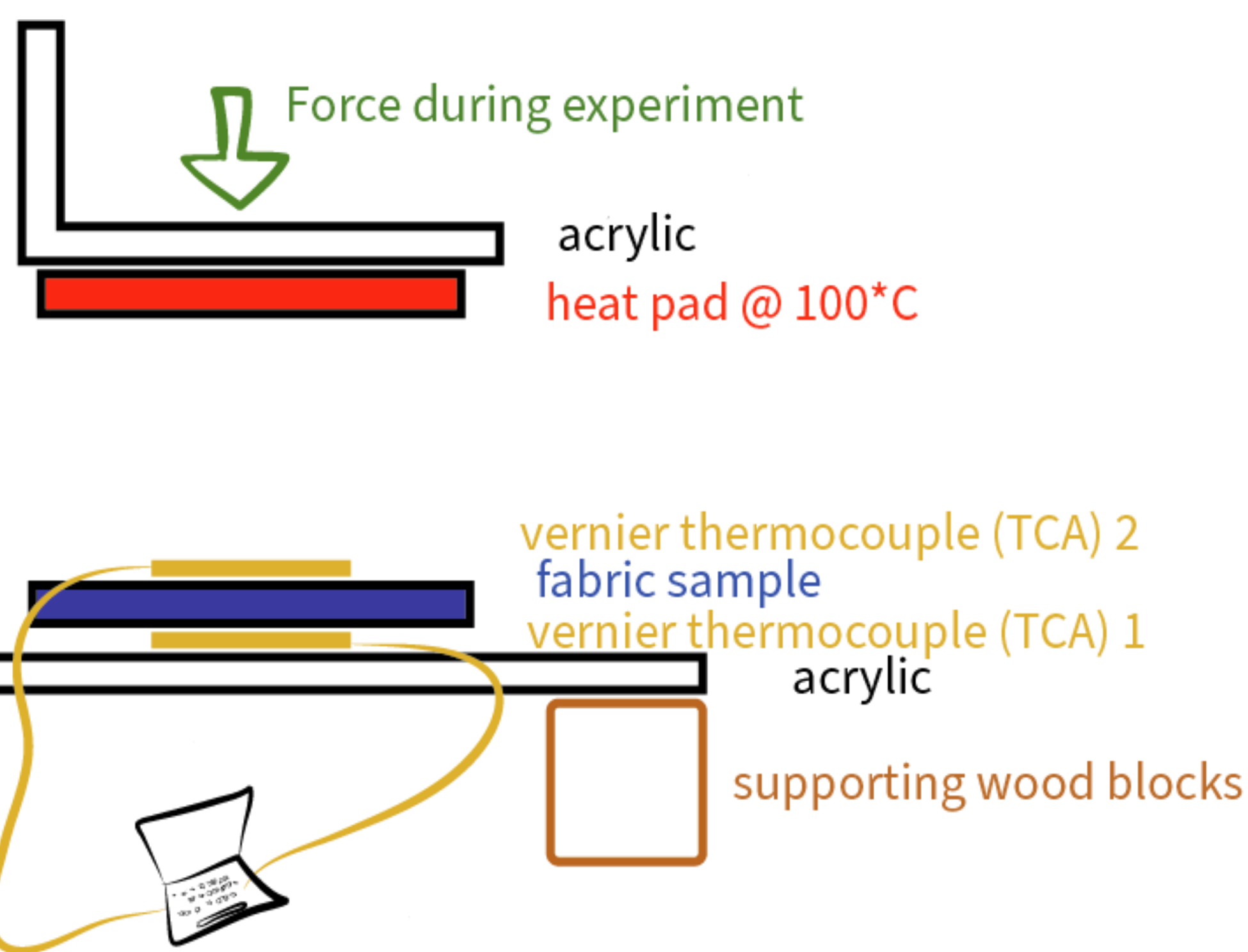
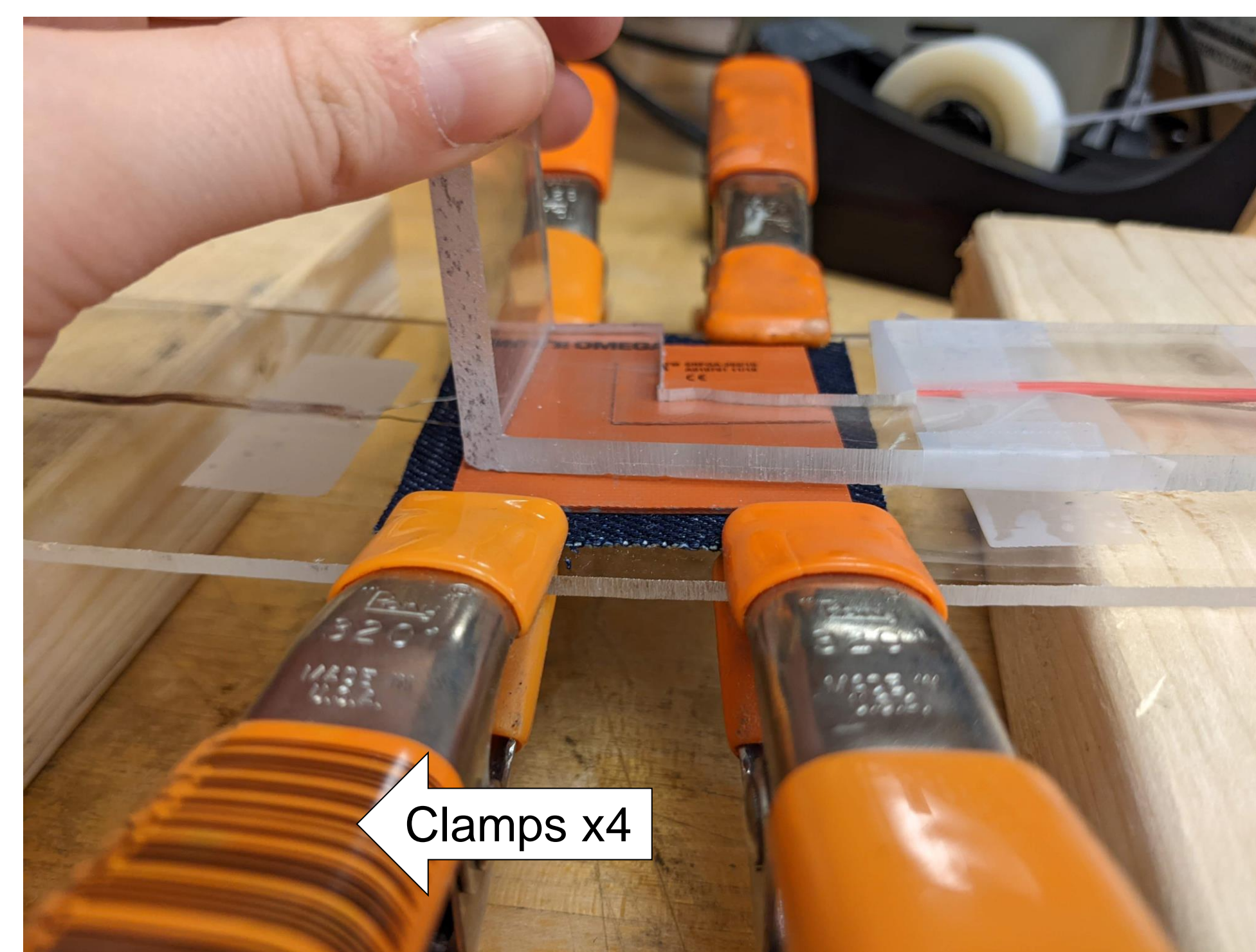
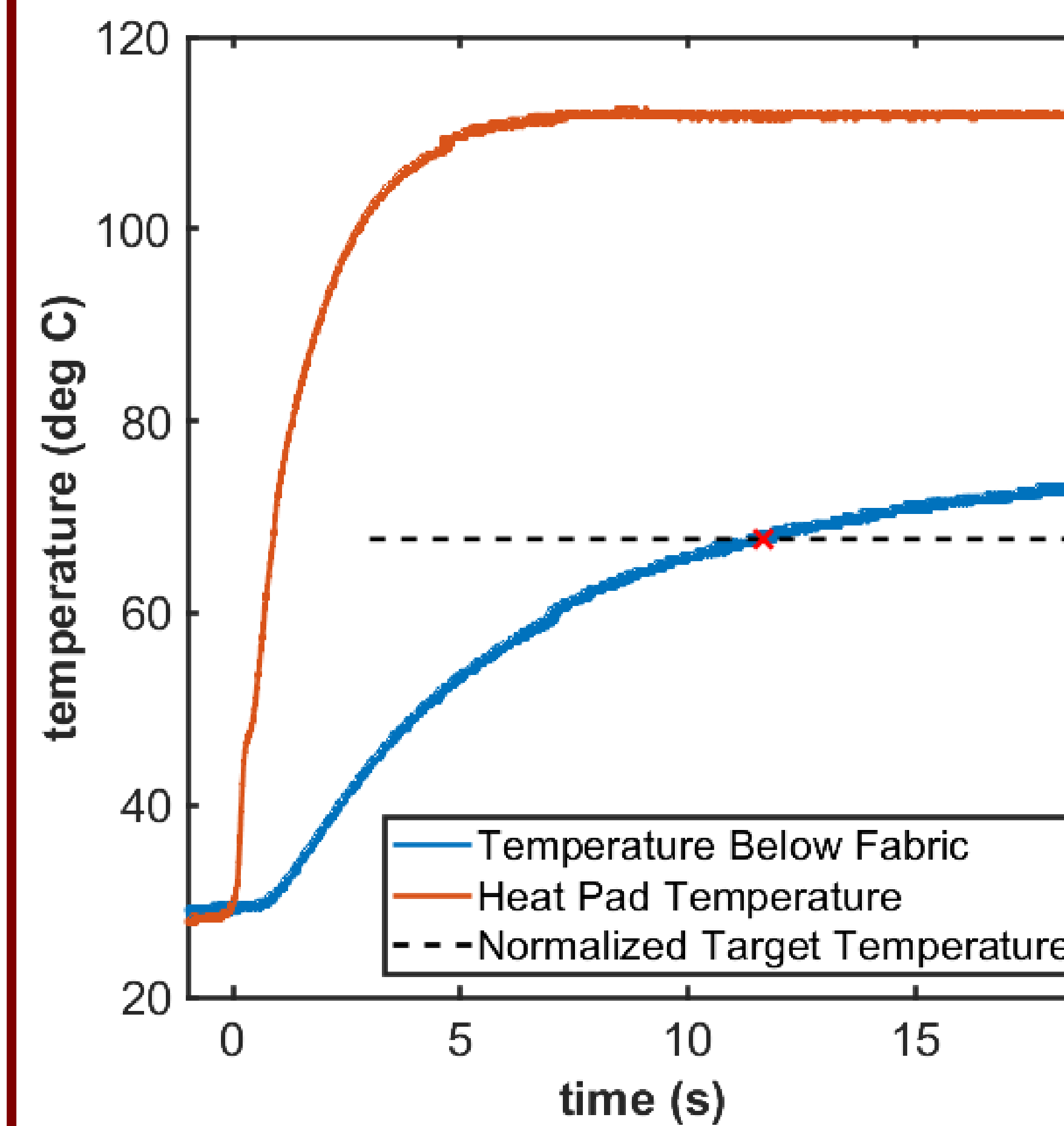


Photo of Setup During Experiment



Experiment



Normalized Target Temperature was determined using the set of measured and nominal values shown below:

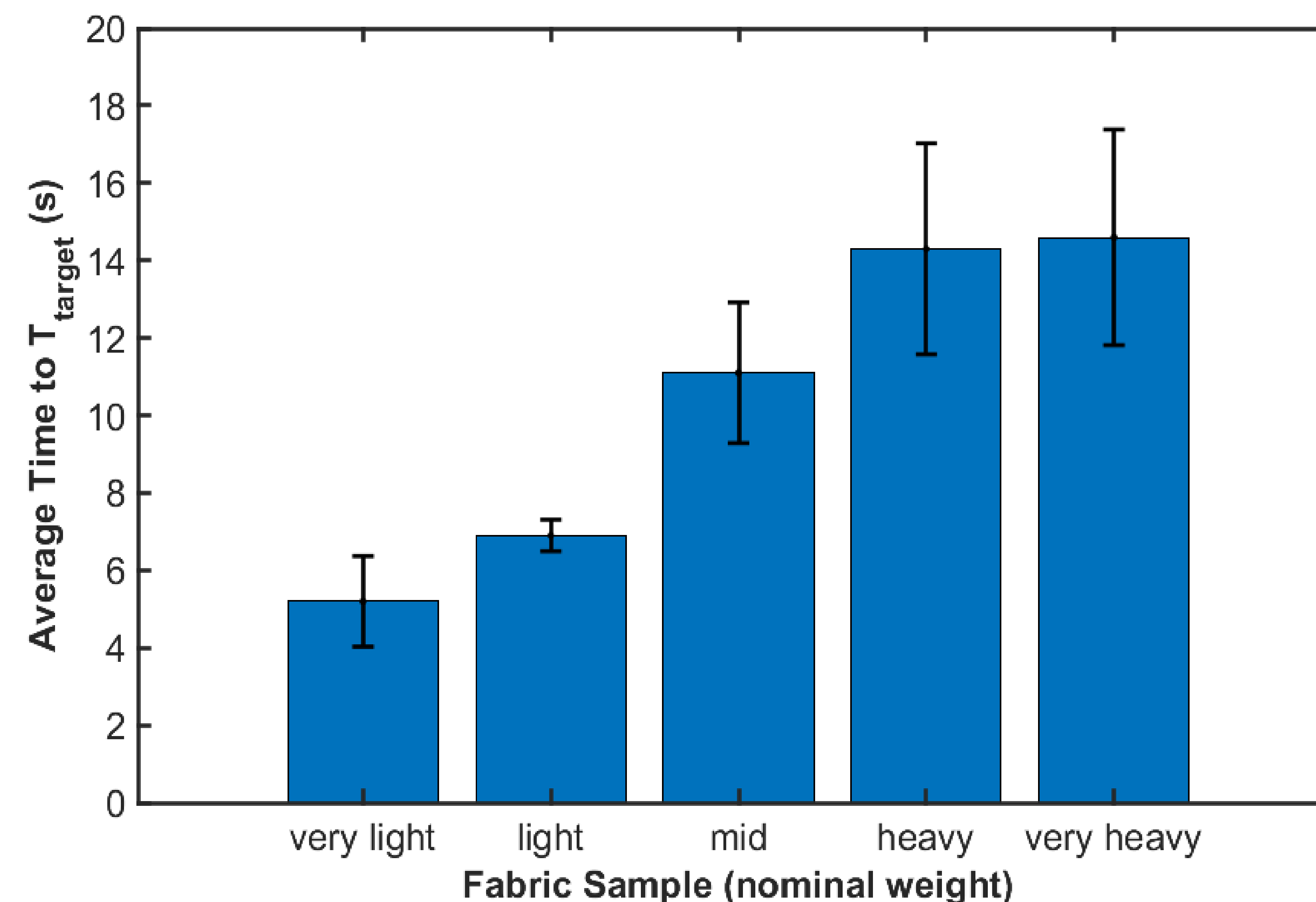
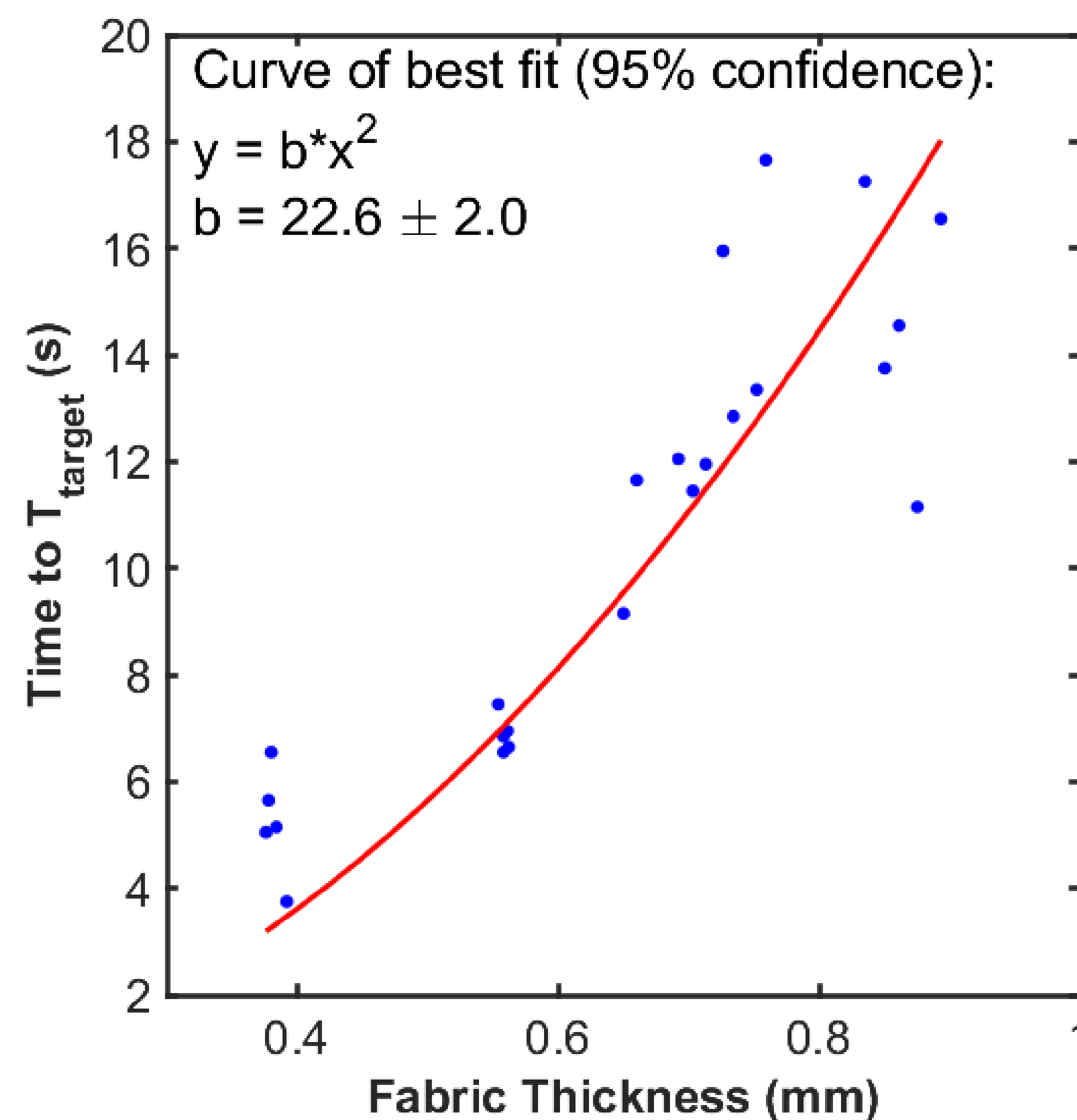
$$\frac{T_{target} - T_{i,meas}}{T_{s,meas} - T_{i,meas}} = \frac{60 - 25}{100 - 25}$$

Therefore making T_{target} equal to:

$$\frac{(60 - 25)(T_{s,meas} - T_{i,meas})}{100 - 25} + T_{i,meas}$$

During each experiment, the heat pad was quickly placed on the fabric and the temperatures recorded for 20 seconds. The experiment above is from a nominally midweight fabric sample.

Results and Conclusions



- There is a clear correlation between thicker denim fabric and longer protection time.
- Even extremely lightweight denim, 6 oz/yd, will protect skin from burns from a 100° C heat source for about 5.2 ± 1.2 seconds.
- Midweight (common) denim fabric, 10 oz/yd, offers about 11.1 ± 1.8 seconds of protection.

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