OTF Foamglass Tests

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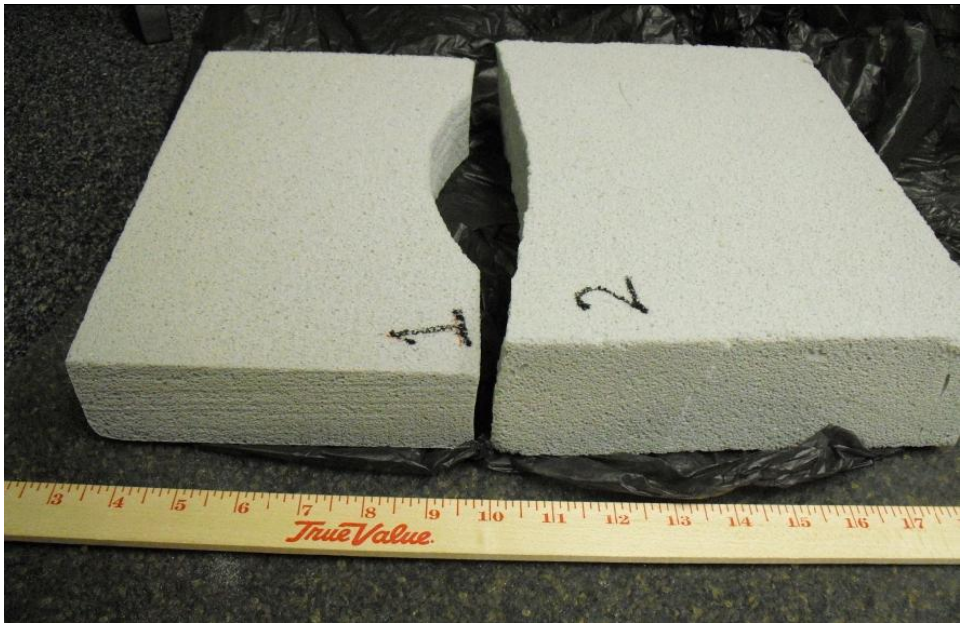
Goals of Phase I

Measure the Linear Coefficient of Thermal Expansion (CTE) for the foamglass that OTF Designs uses in its composite "Starstone" mirrors.

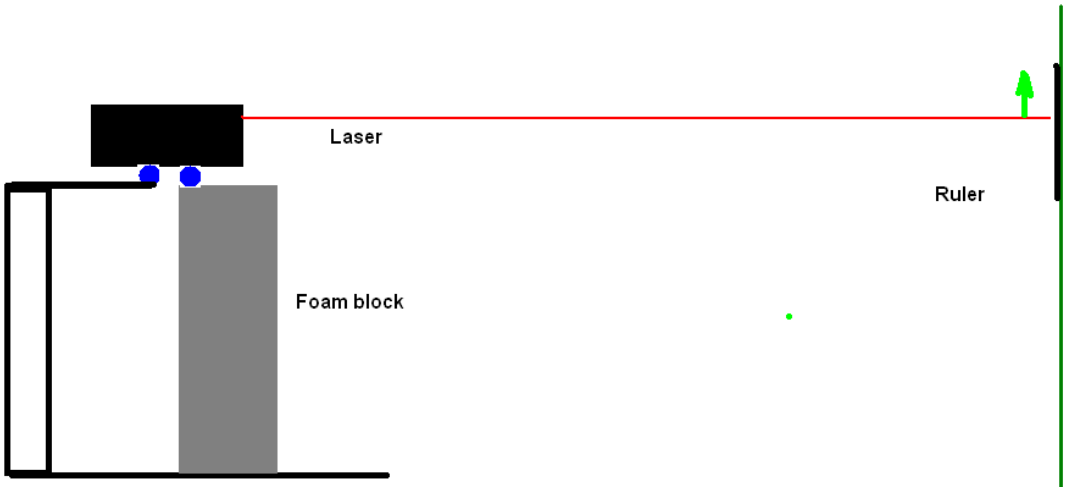
Equipment & Experiment

We started with two foamglass samples provided by Andrew Aurigema from OTF Designs. Both are about 28.5 cm tall. Sample 1 is about 4.8 cm thick and has a density of about 0.15 g/cm^3 (0.0054 lbs/in^3), Sample 2 appears to have larger pores and is about 6.3 cm thick 0.11 g/cm^3 (0.0041 lbs/in^3),

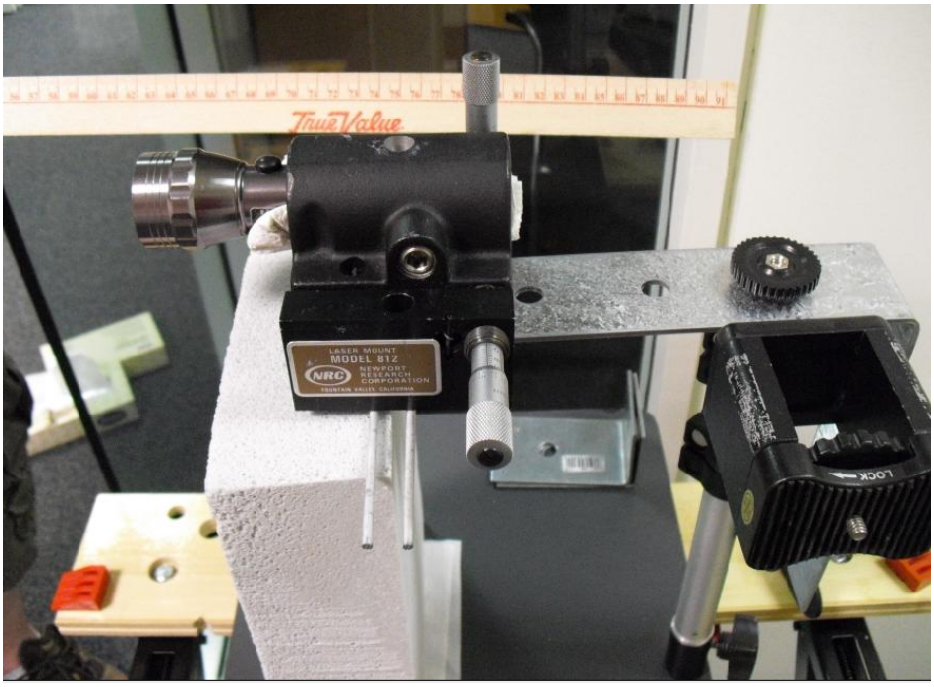


OTF Designs provided foamglass samples.

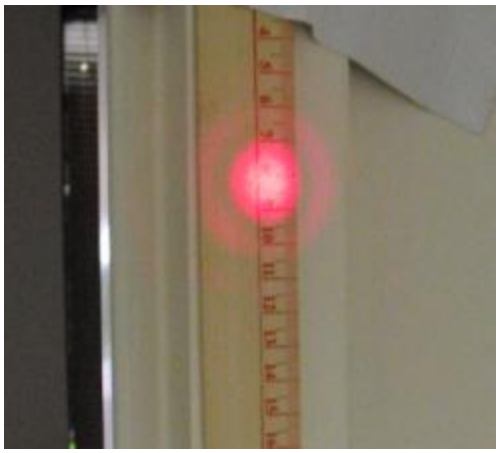
A red diode laser flashlight was mounted in an adjustable laser holder, positioned on top of two horizontally placed rods, and aimed at a wall 53.5 feet away.



Experimental setup. The blue circles represent horizontally placed rods.



Picture of experimental setup. The orientation is reversed from the layout in the previous picture, so the laser leaves to the left. The block is 28.5 cm high.

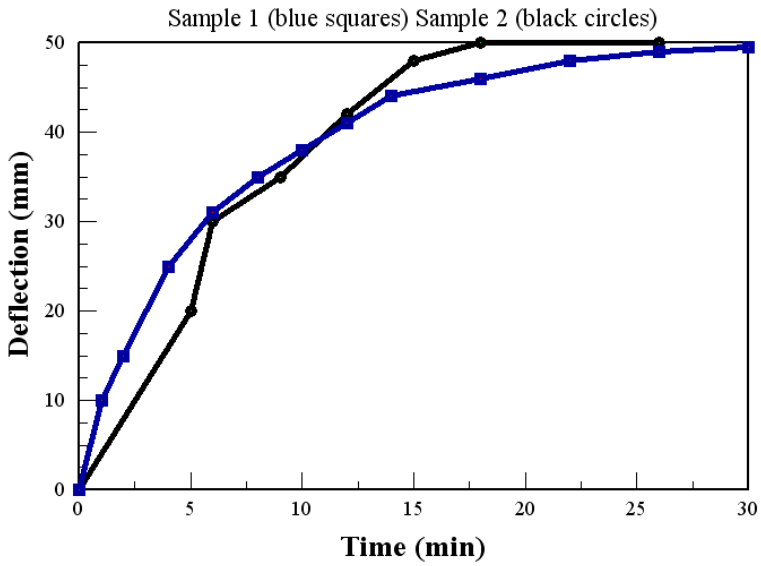


At the wall 53.5 feet away, the laser spot was about 2 cm in diameter. The error in measuring the position was about +/- 0.5 mm.

The foamglass samples were placed in a freezer overnight. The freezer was measured with a PE model T7350 temperature meter to be 10.0^{O} F. The room temperature where the experiment was run was at 74.0^{O} F.

Experimental Results

Sample 2 was processed first followed by Sample 1. The horizontal bars were 25 mm for Sample 1 and 12 mm apart for Sample 2. The blocks were immediately removed from the freezer and placed in the experimental setup and left to equalize with the ambient room temperature.



Sample 2 equalized somewhat faster than Sample 1 (17 vs. 27 minutes). The following formulae were used:

$$CTE = \frac{\Delta h}{H\,\Delta T}$$

where *H* is the block height and

$$\Delta h = \frac{Max\ deflection\ x\ Rod\ separation}{Distance\ to\ wall}$$

For our samples the maximum deflection was 50 mm.

	Δh (mm)	*H (mm)*	*ΔT (^{O}C)*	*CTE (ppm/^{O}C)*
Sample 1	0.077	285	35.6	7.6
Sample 2	0.037	285	35.6	3.6

Formal error estimates were not propagated. However, all measures were under +/- 10% so the final results are probably within +/- 20%.

Some conclusions

A. The CTE of the denser foamglass (Sample 1) is almost double the CTE of the other sample. Perhaps this is due to the manufacturing process not properly mixing or heating the ground glass and foaming agents.
B. Sample 2 type foam glass has a superior CTE to Sample 1. However, the CTE of plate glass is around 8.6 ppm/ ^{O}C. Less stress may result if the glass used in the composite mirror has a lower CTE. Pyrex 7740 has a CTE of 3.2. That glass might be a great glass to use in Starstone mirrors.

Acknowledgement

David Davis suggested the technique of freezing the block under test to accentuate the temperature change.

Reference

Glass types **http://www.oldham-optical.co.uk/Glass.htm**