Status of Gr/Glass Composites Technology at UTOS

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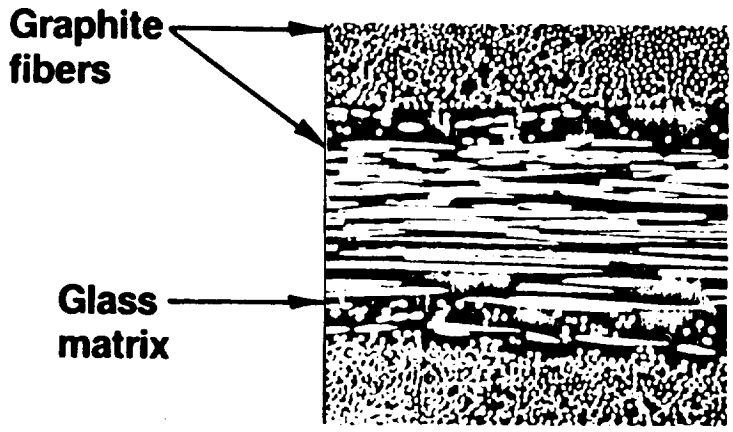
TSC^{tm} (Thermally Stable Composite) refers to a family of graphite reinforced glass matrix composite materials developed by the United Technologies Research Center. This fiber/matrix combination exhibits low coefficients of thermal expansion (CTE), exceptional dimensional stability, high specific strength and stiffness, adequate fracture toughness, and space environment compatibility. Since there is a considerable need for applications involving space-based precision components (such as LDR), TSC offers a high potential for these applications.

TSC evolved from a concept for a hot structure environment application to become a leading candidate for thermally stable applications, once it was realized that a near-zero CTE, that was also relatively constant with temperature, could be attained with this material. For instance, two TSC formulations consisting of continuous HMU and discontinuous GY-70 graphite fibers, respectively, in a borosilicate (Pyrex) glass matrix, exhibit composite CTE values that closely parallel those of ultra-low expansion (ULE) glass, and are somewhat lower than those of fused silica glass. These formulations are an example of the tailorability of the material properties. For instance, the continuous HMU fibers are disposed in an alternating orthogonal sequence (0/90) which produces a low in-plane CTE at just above room temperature. On the other hand, the more uniform, isotropic distribution of the discontinuous (chopped) GY-70 fiber, not only exhibits a low CTE, but it is also relatively constant over a wide temperature range.

The dimensional stability of a TSC mirror structure was experimentally characterized at the Steward Observatory, University of Arizona. A 30-cm diameter non-plano (f/2.5) TSC mirror was assembled from hot-pressed and frit-bonded TSC details into an egg-crated sandwich structure. A HMU (3 K)/Pyrex (45% fiber volume, nominally) system was used to fabricate this panel with (0±45/90) facesheets and (0/90) core webs and backsheet. The resulting area density of the final assembly was 11.4 kg/m^2. The facesheet was polished and reflectively coated to provide a surface adequate for 10.6 μm interferometry. Focus and astigmatism errors were 1.8 μm (p-p) and ±0.8 μm (p-p), respectively, over the ±0°C to -60° test temperature range. Residual distortion was approximately 0.3 μm RMS. Also, print-through of the egg-crate core was not observed, unlike some of the other composite panels.

Preliminary results indicate that TSC is significantly more thermally stable than most other current structural composite materials. In addition, the use of lower CTE glass matrix materials, such as 96% silica glass, have the potential for producing Gr/glass panels with expansion rates and stability comparable to that of fused silica.



- **Graphite fibers in a glass matrix provide**
  - **Tailored CTE/dimensional stability**
  - **High specific strength & stiffness**
  - **High fracture toughness**
  - **Flexible fab procedures**

FIGURE 1. TSC^{tm} - Thermally Stable Composites