HGC Window Test - Kevlar-Mylar with Circumferential Epoxy Coating

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As part of the prototyping process for the SoLID Heavy Gas Cherenkov detector (HGC), a suitable material for the entrance window must be found. The HGC will be filled with gas at a pressure of approximately 1.5 atm, or 22.05 psi (that is, 0.5 atm or 7.35 psi overpressure), and must fit in the SoLID assembly at Jefferson Lab Hall A. As such the material must not only withstand the pressure difference, but do so with minimal bulging (no more than approximately 10 cm). In this trial, a single layer each of Kevlar and Mylar, with epoxy resin around the circumference was tested.

1 Procedure

Mylar and Kevlar samples have been aquired from Challenge Sailcloth [1]. The Mylar has a thickness of 5 mil and is crosshatched with strands of carbon fiber and fiber glass. The Kevlar has a thickness of 12 mil and comes with an adhesive backing, which has been used to bind the layers. A single layer of Kevlar over a single layer of Mylar has been tested. The material was cut to the shape of the prototype window frame, as in the design for the HGC. Previous testing [2] indicates that epoxy may increase the tensile strength of the material, so LePage epoxy resin was then applied to the circumference and given 24 hours to set, before the material was mounted on the prototype frame. The schematic for the window is shown in Fig. 1.

The window was then fixed to a steel plate with an O-ring to provide an airtight seal. A ruler was fixed above the window in an apparatus which allows the ruler to slide up and down, resting against the window. Air was pumped through a hole in the under side of the plate using a bicycle pump attached to a pressure gauge and valve. Fig. 2 shows the setup.

Measurements were taken by closing the vavle at desired pressure values, and reading the ruler against the ruler's holding apparatus. The initial reading at zero pressure is taken to be a deflection of 0 cm.

In previous tests [2] a soak test was performed to determine the window's ability to hold

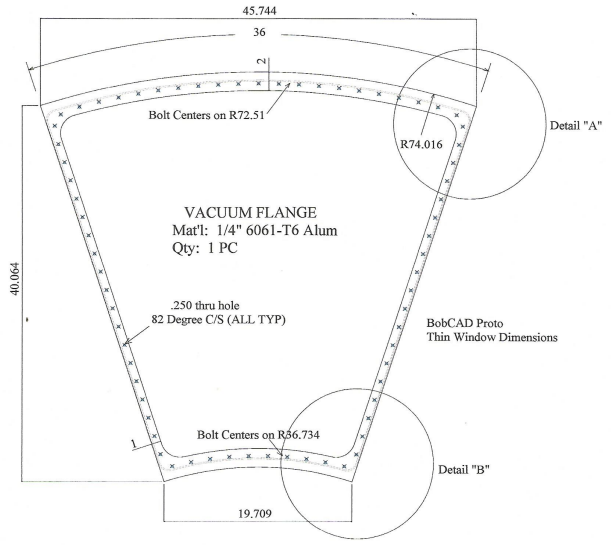

Figure 1: Schematic diagram of the HGC detector window.

pressure over time. Due to observed leaking during the test, the decision was made to forgo the soak test for this trial.

2 Results

Air was pumped in until the pressure gauge read 7 *psi*, where the window had bulged to a height of 6.85 *cm*. The deflection versus the pressure is shown in Fig. 3 by the red points.

At this point, the deflection was noted to be slowly decreasing. Using a spray bottle with a soap and water mixture, several leaks were identified around the circumference of the window. The window was then deflated and disassembled, and reassembled with additional vacuum grease on the O-ring, and different bolts to allow tighter clamping.

The window was then inflated again, however at 7 *psi* leaking was once again noted around the circumference. The decision was made the forgo the soak test and continue inflating the window until failure.

The window reached a pressure of over 15 *psi* and deflection of at least 9.05 *cm* before failure. While pumping beyond 15 *psi* the material tore from the frame along one edge and burst. The window after failure is shown in Fig. 4.

3 Summary and Conclusions

The bulging in this material does not satisfy current requirements for the HGC. The deflection at 7 *psi* overpressure was found to be 6.85 *cm*. This is approximately 0.25 *cm* greater than the deflection in the same material without the epoxy as found in the previous test [2]. This finding is unexpected as it appears to be contrary to tensile strength tests performed on these same materials both with and without epoxy [2].

The maximum pressure reached by this material before failure was at least 15 *psi*, which is a substantial improvement over the previous maximum of 10 *psi* [2]. The point of failure would appear to be shear force at the along the longest edge of the window, rather than slipping from the clamp as before [2].

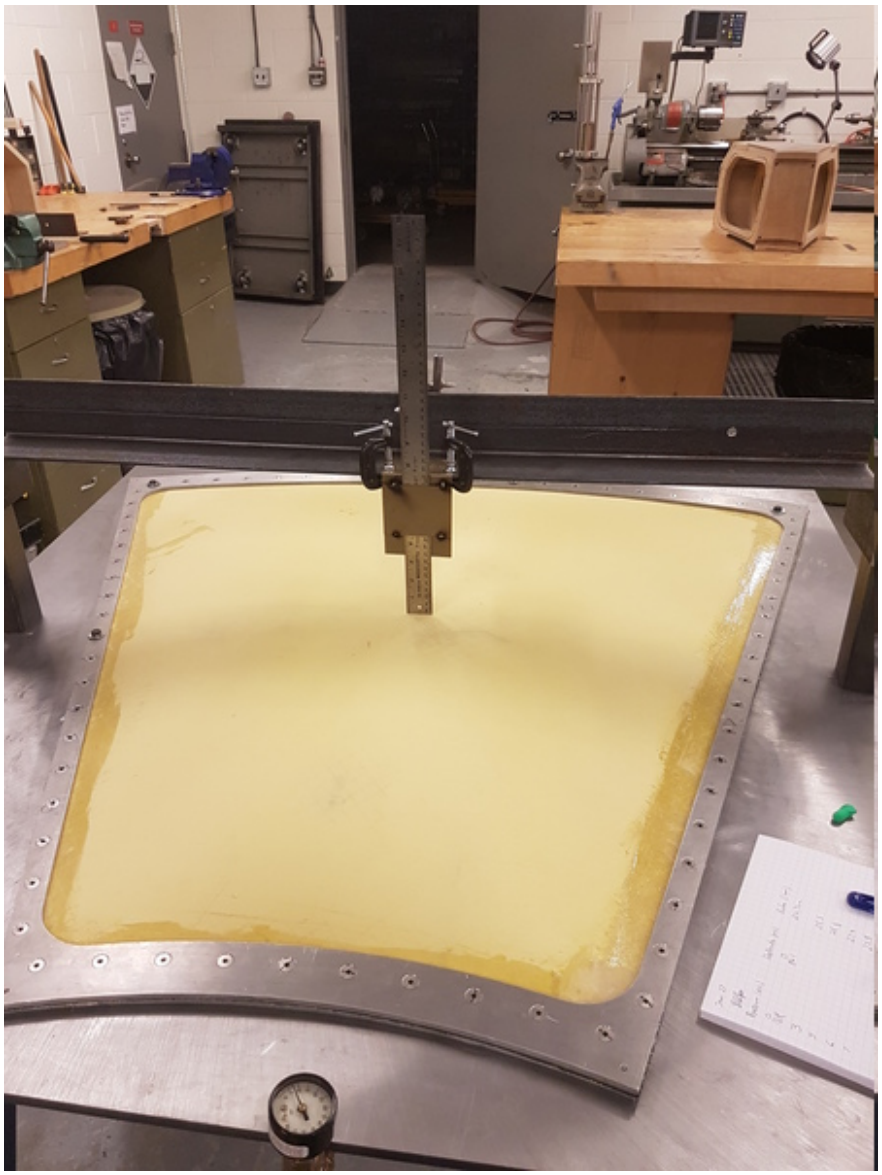

Figure 2: Photograph of experimental setup.

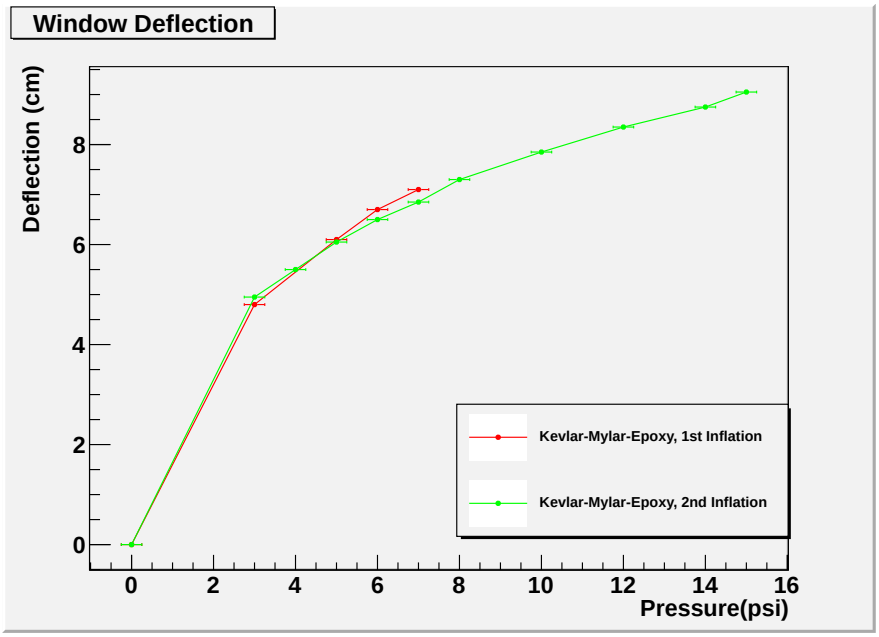

Figure 3: Graph showing height of the bulge in the window versus pressure both before and after deflating the window. Note that there was no soak test between the two inflations, so the difference is minimal.

Figure 4: Photo showing the window after it failed.

References

[1] Challenge Sailcloth, Inc. 711 W 17th St, Cosa Mesa, CA 92627-4345. 949-722-7448

[2] Evans, R. S., et al. Heavy Gas Cherenkov Detector: Window Material Pressure Test, *Unpublished* (2016).