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# LARGE RECTANGULAR VACUUM WINDOWS\*

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## Summary

A combination of dacron sail cloth and mylar film is used for large vacuum windows in secondary beams at the Bevatron. The dacron cloth provides the structural strength and the mylar film provides the gas barrier. Windows of this type have three principal advantages over plain mylar of equivalent strength:

1. Safer, will not catastrophically fail;
2. Forms square corners;
3. Less dense.

This paper discusses the development, testing, and fabrication techniques of several such windows in use.

## Development

The development was begun to meet an experimenter's request for a 18 x 40 in. thin vacuum window with a minimum radius in the corners. It was felt that mylar alone would not form the required square corners, but that if backed with cloth such a window might be possible. Many cloths were tried including balloon cloth, nylon, polypropylene, and fiberglass before selecting dacron sail cloth as having the best strength-to-weight ratio. The materials finally chosen were 9 oz dacron sail cloth manufactured by Texlon Corporation of Torrance, California, and 5 mil mylar. The 9 ounces refers to the weight of a sail maker's yard which is 28 x 36 in. See Fig. 1 for a list of thicknesses and densities of various weights of dacron cloth. Two 18 x 40 in. windows and a 16 x 28 in. window were used on a large vacuum tank in an experiment for two years. During this time the windows were cycled air to vacuum many times with no leaks or other apparent damage.

Figure 1

| Dacron<br>sail cloth<br>weight (oz) | Approx.<br>thickness |        | Density<br>gm/cm <sup>2</sup> |
|-------------------------------------|----------------------|--------|-------------------------------|
|                                     | in.                  | mm     |                               |
| 3                                   | 0.0053               | 0.0135 | 0.014                         |
| 5                                   | 0.0091               | 0.0231 | 0.021                         |
| 6.5                                 | 0.0125               | 0.0318 | 0.030                         |
| 8.25                                | 0.0143               | 0.0363 | 0.032                         |
| 9                                   | 0.0156               | 0.0396 | 0.037                         |
| 13                                  | 0.0210               | 0.0533 | 0.055                         |

Another window presently in use is 12 x 144 in. with 13 oz dacron cloth and 5 mil mylar. A heavier cloth was used for added safety because the experimenter has to work within inches of the window (Fig. 6). Presently being fabricated is a window of 6.5 oz dacron cloth with 5 mil mylar on a 10 x 30 in. frame.

## Tests

For each size window a cloth was selected which held a maximum pressure of 4 atm before rupture. This test was done hydrostatically by increasing the pressure about 1/3 atm every 5 min until rupture. Rate of pressurization affects the rupture pressure and may result in false readings. Cloths which pass this test are then pressurized to 3 atm and long-term creep is observed. At this pressure the window continues to deflect at a decreasing rate for about 2 weeks when it becomes stable.

To determine what would happen when punctured, the 18 x 40 in. window of 9 oz dacron and 5 mil mylar was installed on a large vacuum tank inside a concrete blockhouse. The tank was evacuated and a 1/4-in. diam rod with a chisel point was pushed through the window. The result was just a 1/4-in. diam hole in the window which slowly let the tank up to air (Fig. 7). It did not rip or fail catastrophically as would be expected from a plain mylar window.

## Fabrication

The dacron cloth and mylar are epoxied\*\* onto a window frame which is placed between a clamp ring and the vacuum tank. The epoxy fills the weave of the cloth and provides the vacuum seal between the mylar and the window frame. The seal between the window frame and the vacuum tank is made with a conventional O-ring (Fig. 2). Before assembly both the mylar and the window frame are fine sandblasted in the area where epoxy will be applied to provide a good bonding surface. The dacron cloth is then sandwiched between the mylar and the frame and a small clamp bar is placed at the edge of the window. This prevents any epoxy from running over the radius which could cause an edge failure. Next epoxy is applied between the cloth and frame and between the cloth and mylar. After squeezing out all air bubbles, the assembly is clamped and allowed to dry over night (Figs. 3 and 4).

## Precautions

The dacron sail cloth used at the Bevatron is directional in weave. The cords across the 28 in. width are pulled tight and the cords running lengthwise loop around (Fig. 5). By having the tight cords in the high stress direction about a 20% increase is gained in strength and the deflection is reduced by about 20%. A difference was also noted in strength between cloth of the same weight but cut from different bolts of material or from different manufacturers.

A last precaution to be noted is that the strength of the various dacron cloth tested did not vary proportionately with the weight of the material.

\*Work performed under the auspices of the U. S. Atomic Energy Commission.

\*\*Epoxy mix: 50% Shell Chemical Company Epon 820 and 50% General Mills Corporation Versamid 140.

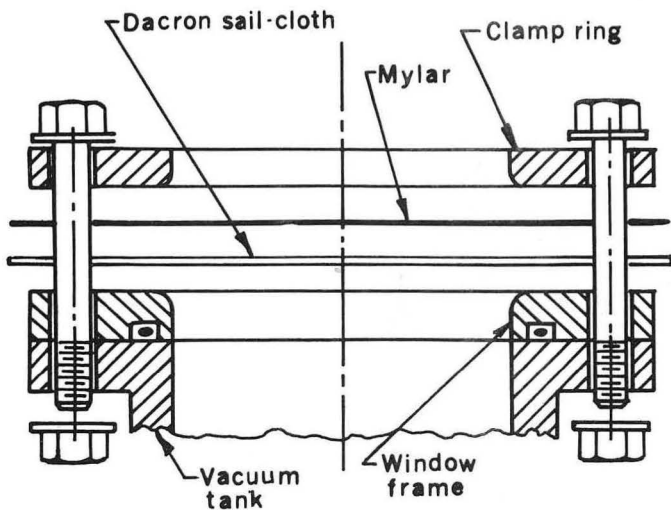


Fig. 2. Window assembly.

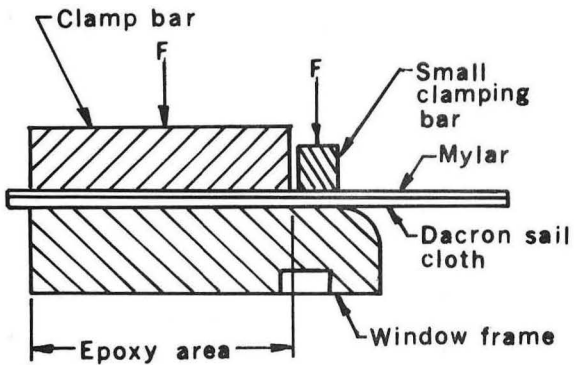


Fig. 3. Epoxy procedure.

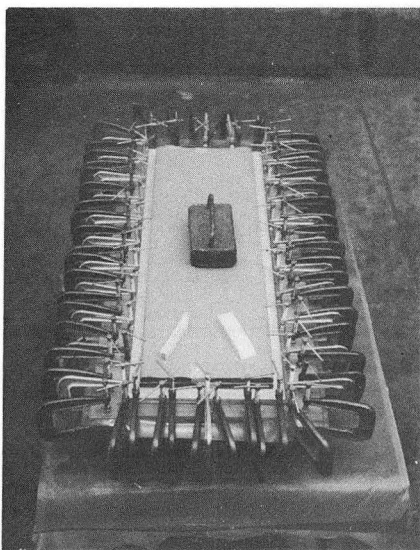


Fig. 4. Clamping procedure.

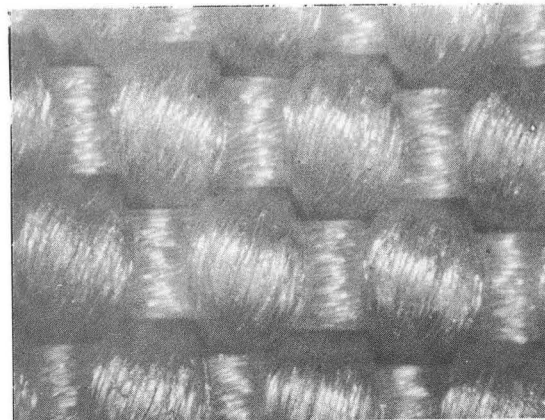


Fig. 5. Dacron sail cloth 60X  
Tight cords horizontal, looped vertical

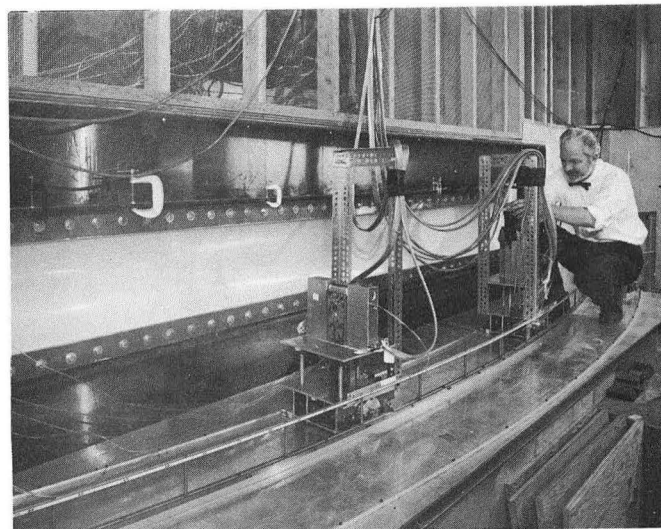


Fig. 6. 12 x 144 in. vacuum window for heavy ion experiment. Dr. H. Heckman shown adjusting equipment.

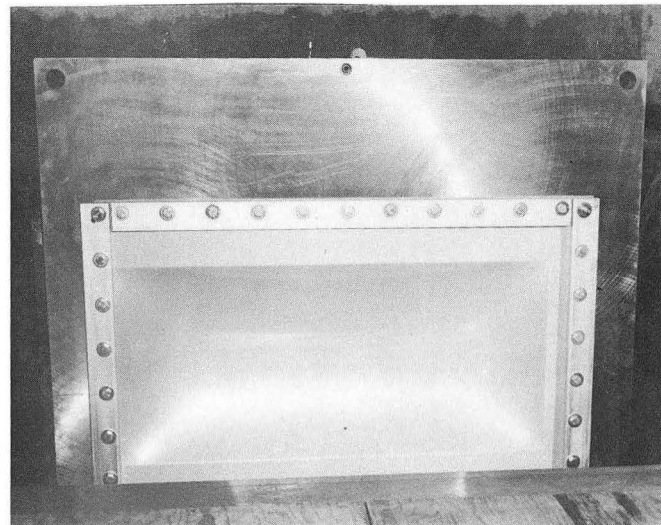


Fig. 7. 18 x 40 in. vacuum window with square corners. Note small puncture hole lower edge.

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