THE CONSTRUCTION AND DEVELOPMENT
OF A THIN-WALLED HIGH-PRESSURE GAS TARGET

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1. INTRODUCTION

This note describes the construction and development of thin-walled, high-pressure helium gas targets for a spectrometer which was used to reconstruct the trajectories and measure the kinetic energies of alpha particles recoiling from high-momentum $p + {}^4\text{He}$ or $\pi + {}^4\text{He}$ collisions^{1,2}). The range of alpha-particle energies involved was between 4 and 80 MeV.

2. REQUIREMENTS

The general requirements for the targets were as follows:

- a) In order to get adequate collision rates, it was necessary to construct cylindrical targets 550 mm long $\times$ 20 mm in diameter which could support internal pressures of 600 kPa or 2000 kPa.
- b) The cylinders were required to have thin end caps, in order to minimize the scattering of the incident beam, which was directed along the axis.
- c) The cylinders were required to have at least 315° of useful azimuth for the escape of recoiling alpha-particles.
- d) The transparency within the useful azimuth was to be at least 80%.
- e) The wall should be as thin as possible in order to minimize the energy loss of the recoils.

The final design (Fig. 1), consisted of a cylinder of polyimide film, the thickness of which was chosen to withstand the desired working pressure, supported by an external wire spiral.

3. THE CYLINDER SUPPORT

A support cage for the target cylinder was made by forming 0.4 mm ϕ stainless-steel wire into a spiral coil 20 mm ϕ , with 250 turns. The coils were held on a former with a spacing of 2 mm between turns, and three longitudinal wires, 1 mm in diameter, equispaced around the cylinder, were spot-welded to the coils. The resulting support cage was cleaned by electrolytic polishing. An aluminium cylinder was attached to each end of the cage by spot-welding the three longitudinal wires to a spiral spring inserted into a groove in the cylinder. A 5 mm O.D. tube was screwed radially into each of the end cylinders. These tubes served as supports for the cage and as gas connections for the target.

4. THE CYLINDER

The material used for the cylinders was Kapton^{*)} (type H) polyimide film. The thicknesses selected, after some preliminary pressure tests, were 8 μm and 25 μm . To construct the cylinders, a 1 mm $\varnothing$ steel rod, coated with rapid Araldite^{**)}, was laid along one edge of a strip of film 560 mm long by 80 mm wide, and the opposite edge of the film was folded over and pressed on the top of the rod. The folded strip had a 20 mm $\varnothing$ plastic rod containing a 5 mm $\times$ 5 mm groove along its length, inserted between its folds. The rod was located along the groove, a layer of Araldite 107^{**)*)} was applied along the trough formed by the rod and the adjacent Kapton film, and the rod was rotated to draw the film to the diameter of the plastic rod, trapping some of the adhesive in its rolls. The tension in the rolled seam was held with suitable clamping and the surplus adhesive was wiped away, leaving a fillet of adhesive in the "V" of the rolled joint, to ensure a circular outer section for the target cylinder (Fig. 2). The 1 mm rod remained in the seam. The plastic rod was removed after the adhesive had set.

5. ASSEMBLY

The target cylinder was placed inside the support cage and sealed with a layer of Silastic^{***)} 732 RTV to the inside surface of the end cylinders. After the adhesive had set, the target was trimmed to the length of the support cage and small holes were pierced at each end of the cylinder to the gas inlet and outlet pipes.

The end caps were moulded to shape from film polyethylene terephthalate. A film thickness of 120 μm was used with the 8 μm cylinders, and 200 μm with the 25 μm cylinders. The flanges of the end caps were coated with Araldite 103^{**)*)} and the caps were slid onto the end cylinders of the cage. An external binding of nylon thread, coated with Araldite 103, was used to reinforce the flanges, as shown in Fig. 3.

The complete target was mounted on a support beam, which accurately positioned the target along the axis of the recoil spectrometer.

6. PERFORMANCE

The targets were tested for one week, at 600 kPa for the 8 μm cylinders and at 2000 kPa for the 25 μm cylinders. There were usually a few minute pin-hole leaks from the body of the 8 μm cylinders.

*) DuPont.

**) Ciba (ARL) Ltd.

***) Dow Corning.

The targets were used in the recoil spectrometer for a total of 17 weeks during 1973 and 1974, at working pressures of 500 kPa and 1500 kPa, respectively. One 8 μ m cylinder developed a serious leak after several days use. This was the only failure during the whole of the above period, and is thought to be due to abrasion of the Kapton by a rough spot on the support cage when the target pressure was cycled several times in rapid succession between 100 kPa and 500 kPa. The remaining 8 μ m targets were cycled at infrequent intervals and behaved perfectly satisfactorily. There was no evidence for the enlargement of pre-existing pinholes in the material, even after several weeks of operation.

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REFERENCES

- 1) S. Dahlgren et al., Nuclear Instrum. Methods 103, 309 (1972).
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Figure captions

Fig. 1 : General view of high-pressure gas target.

Fig. 2 : Section of rolled seam on former.

Fig. 3 : End cap detail.

Fig. 1

Fig. 2

Fig. 3