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Laser-Fusion Target Fabrication: Application of a Polymeric Ablator Coating to a Ball-and-Disk Target Design by the Physical Vapor Deposition of Polyethylene

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LASER-FUSION TARGET FABRICATION: APPLICATION OF A POLYMERIC ABLATOR COATING TO A BALL-AND-DISK TARGET DESIGN BY THE PHYSICAL VAPOR DEPOSITION OF POLYETHYLENE

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ABSTRACT

A technique for applying polyethylene by physical vapor deposition is described. The ball-and-disk target design requires the application of a thin film of polyethylene on the front surface of the ball and substrate upon which the ball is mounted. Disk-shaped films, typically 200-μm-diam by 1-μm-thick, are successfully applied by this method.

INTRODUCTION

Thin-film technology is being widely used in the fabrication of targets for laser-initiated fusion. The fabrication of laser-fusion targets, which are made individually, requires that thin films be applied to various microsize substrates. A prime area of interest is organic thin films, which are used in various target designs. Because of the size and nature of laser-fusion targets, unique techniques for the deposition of organic coatings from the vapor state had to be developed and evaluated.

This report describes a technique developed for the ball-and-disk target design, which is shown in Fig. 1. This design consists of a nominal 50-μm-diam glass microballoon containing 50-100 atm of DT gas. The microballoon is mounted on a 1000-Å-thick polymeric film. A 1-μm-thick polyethylene coating is applied to the front surface of the microballoon and to the polymeric substrate for a radial distance of about 100 μm from the center of the microballoon.

PHYSICAL VAPOR DEPOSITION OF THE POLYETHYLENE DISK

The physical vapor deposition (PVD) of polyethylene is somewhat analogous to the PVD of metal; the main difference is the relatively low vaporization temperature (<500°C) of the polyethylene. The coating is applied in a vacuum-evaporator station under an operating pressure of <1 x 10^{-5} mm Hg. A small, weighed charge of polyethylene* is vaporized from an alumina crucible, which is heated by a wrapping of nichrome, resistance heating wire, as shown in Fig. 2. The polyethylene is maintained at ~425°C during vaporization. Splattering of the polyethylene from the crucible is prevented by placing boiling stones in the crucible and a 30-mesh stainless steel screen over the mouth of the crucible. The shape of the polyethylene film is produced by placing a mask with a 200-μm-diam hole over the ball and film mount. The source-to-substrate distance established for this process was 50 mm. Eleven milligrams of polyethylene completely vaporized with the above conditions will yield a 1-μm-thick disk. Figure 3 is a photomicrograph of a ball-and-disk laser-fusion target.

*Alathon 4275, E. I. Du Pont de Nemours and Company, Wilmington, DE.

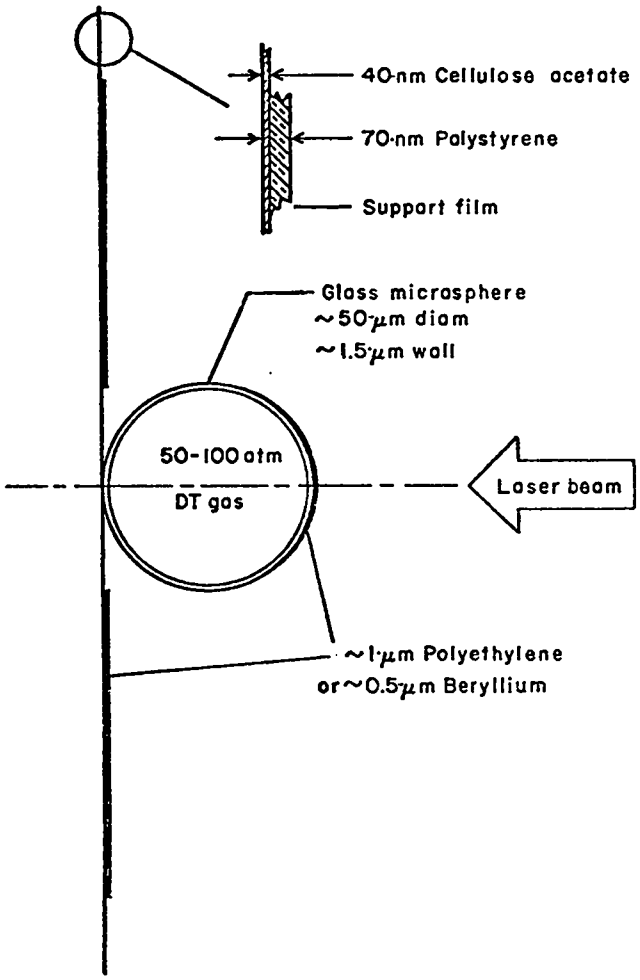

Fig. 1.
Ball-and-disk target design.

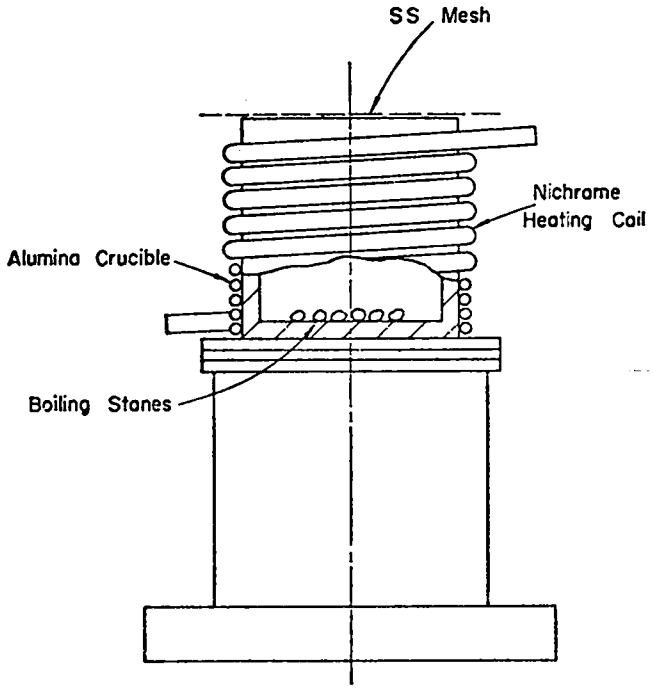

Fig. 2.
Vaporization crucible.

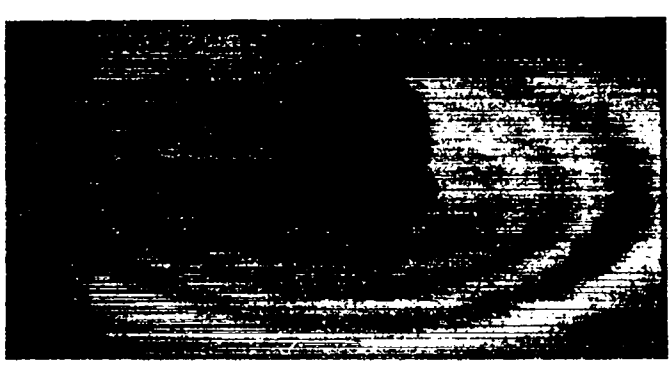

Fig. 3.
Photomicrograph of a ball-and-disk laser-fusion target.