shown in Fig. 6 for both 0.5 and 1 ns irradiation. The on-target intensities were 10^{15} and 5×10^{14} W/cm^2, respectively. The deduced temperatures (0.8 to 1.8 keV) correspond very closely to those calculated with 1-D and 2-D hydro-codes such as LLE's *LILAC* and *SAGE*.

Using Figs. 2 and 6, we have deduced the time-dependent electron temperature in the corona (Fig. 7). Both the temporal behavior and the absolute values of the coronal temperatures track the hydro-code calculations quite well; however, independent coronal temperature measurements are required in order to accept the present technique as a viable coronal temperature diagnostic. Nevertheless, the great potential inherent in the SRS spectra as a coronal temperature diagnostic is demonstrated here for the first time.

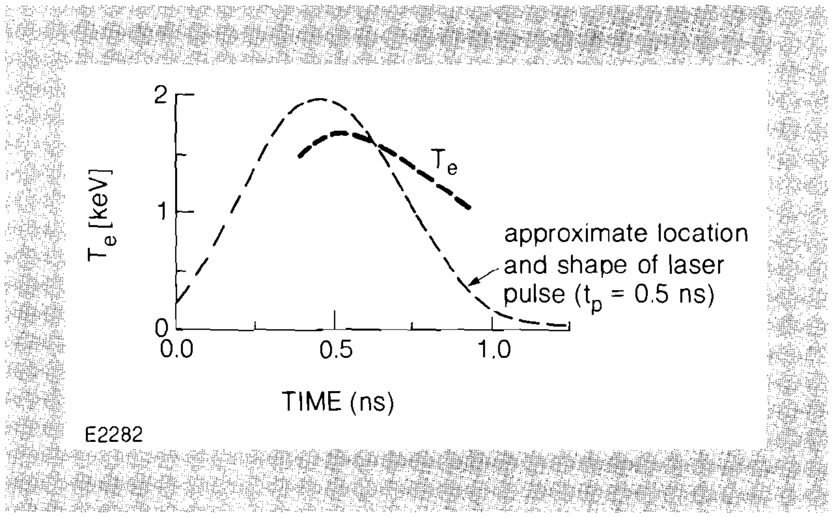

Fig. 7
Time-dependent coronal temperatures deduced from Figs. 2 and 6. The approximate location of the incident laser pulse is also shown.

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2.B Fabrication of Large-Aspect-Ratio, Plastic-Coated, Metal-Shell Targets

A new mandrel material has been found for making large-aspect-ratio, plastic-coated, metal-shell diagnostic targets using the leachable mandral technique. A typical diagnostic target, shown in Fig. 8, has a diameter of 400 μm and material thicknesses of metal and hydrocarbon that are, respectively, 0.3 μm and 3 μm. The diagnostic targets are intended for use as an x-ray source in backlighting experiments[1] or for studying uniformity of implosion. The main difference between this target and typical inertial fusion targets is that this target does not contain a glass microballoon. This required a substantial modification of the usual target fabrication technology.

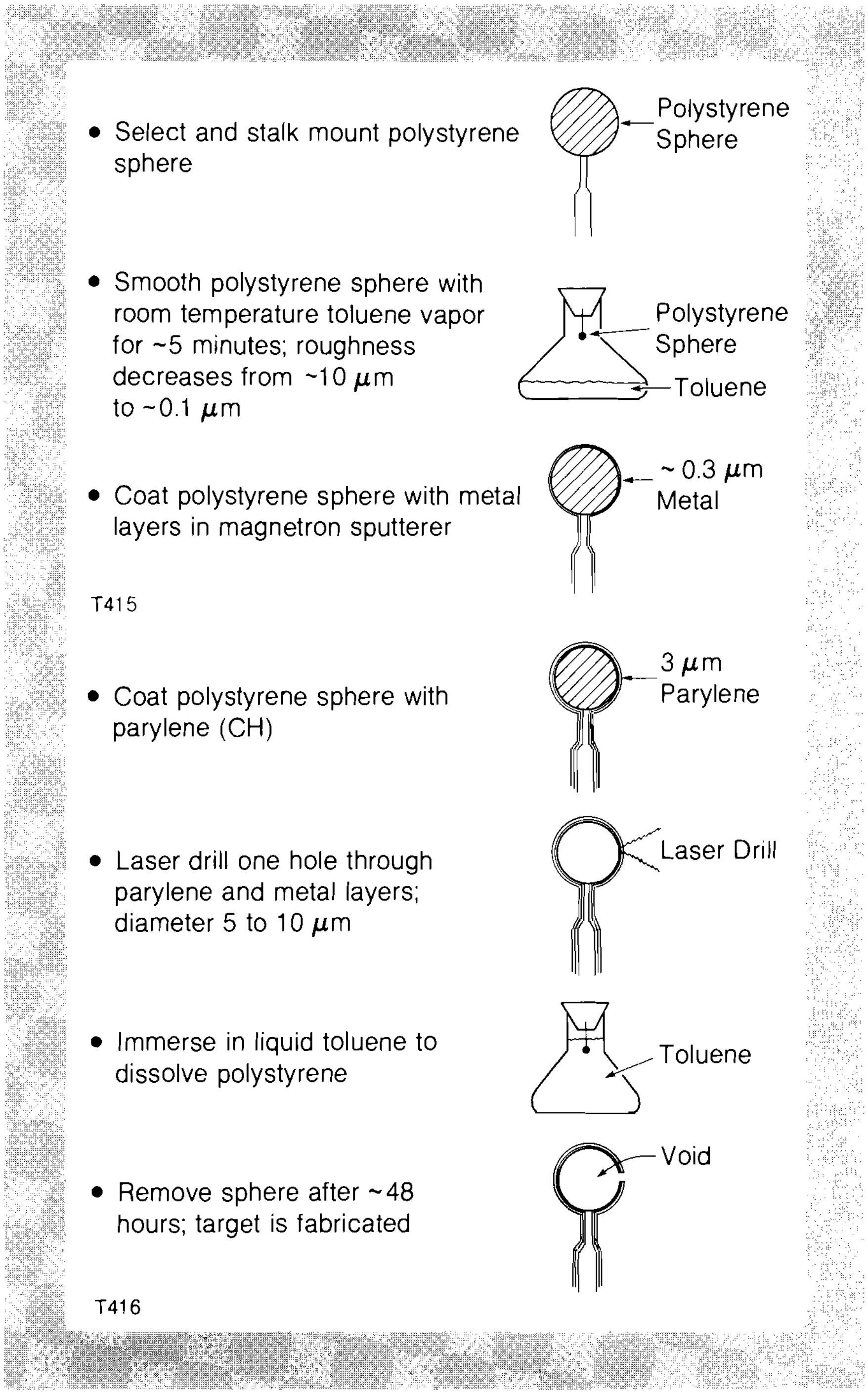


Fig. 8
Sequence for fabricating large-aspect-ratio, plastic-coated, metal-shell diagnostic targets.

A number of different approaches have previously been investigated for the fabrication of such a diagnostic target. These include the hemispherical shell approach,[2] the leachable metal mandrel process,[3] and the coating of a prefabricated metal shell.[4] In the hemispherical shell method, two hemispherical shells are first produced by any one of various methods. Then these half-shells are carefully mated and bonded.

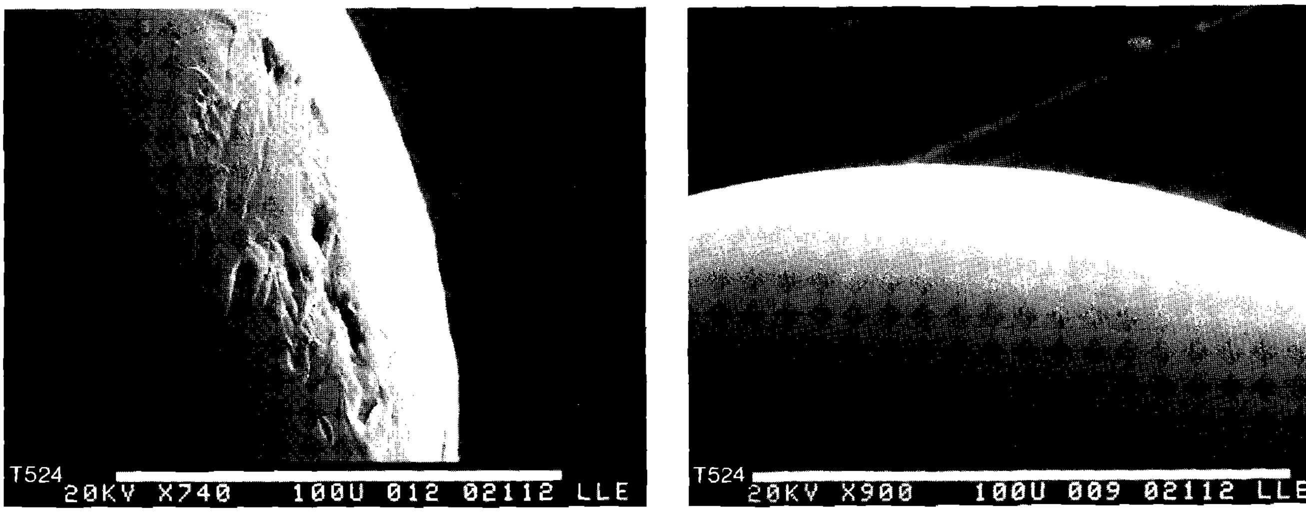
Because of the mechanical handling during this process, the shell walls must be relatively thick. Furthermore, the positioning and bonding process inevitably produces seams and leaves deposits of bonding adhesives. This approach is very time-consuming and requires a highly skilled operator.

In the leachable metal mandrel process, a metal mandrel such as a copper ballbearing is overcoated with a thin metal layer. The copper is then leached through a drilled hole in the coating by a strong acid, leaving a free-standing metal shell. The acid leaching step limits the types of metal shells that can be formed. Paraffin has also been used as the leachable mandrel material to circumvent the acid leaching step.[5] This, however, presents problems during the metal-coating step because paraffin has a low melting temperature. Paraffin mandrel sphericity is also difficult to maintain during the process. Prefabricated, hollow metal shells would simplify the fabrication process by eliminating the entire leaching step. Unfortunately, metal shells currently available are of poor quality, are too thick-walled, and are available in only a single material, a nickel alloy. This necessitated the investigation of more suitable materials for mandrels.

The desired mandrel should be: (1) highly spherical and smooth, (2) easy to coat with various metals while maintaining mandrel sphericity or surface smoothness, (3) selectively leachable through a small hole without damage to the thin metal coating. Spheres of a glassy polymer that are easily soluble at room temperature would meet these requirements. We have successfully developed a fabrication procedure for making the desired high-aspect-ratio, plastic-coated, metal-shell diagnostic targets based on the polymer mandrel.

Figure 8 illustrates the fabrication steps. The sequence begins with a selection of a polystyrene sphere of a proper size and then mounting the sphere on a stalk. The surface finish of commercially available polystyrene spheres is not acceptable but this can be smoothed by exposure to toluene vapor for 5 minutes. This reduces the surface features from approximately 10 μm in height to less than 0.1 μm. A longer exposure deforms the spherical mandrel. The smoothed polystyrene sphere is next coated with the required metal by using magnetron sputtering. This metal-sputter coating should be performed at temperatures below the glass transition temperature of polystyrene, 90°C, or else the polystyrene mandrel will be deformed. After coating parylene over the metal layer, a hole of 5~10 μm diameter is drilled through the coatings by multiple laser pulses from the Diagnostic Evaluation Laser (DEL). The entire assembly is then immersed in toluene for 48 hours during which period the polystyrene mandrel is dissolved and leached out through the hole. Removal of the assembly from the toluene leaching bath leaves a finished diagnostic target.

In this procedure, the surface smoothing step is important because the metal coating replicates the surface texture of the mandrel. Figure 9 shows the surface of the mandrel prior to and after exposure to the solvent vapor. The characterization of the diagnostic target fabricated by this procedure was carried out with an optical microscope. For this in-



(a) (b)

Fig. 9
Surface smoothing of the polystyrene mandrel by solvent vapor.
a) mandrel surface prior to exposure
b) surface after exposure to toluene for 5 minutes.

vestigation, the metal layer was not coated, and a plastic shell was prepared by the procedure detailed in Fig. 8. Figure 10 is an interferogram of the plastic shell and shows the uniform wall thickness produced by this process.

Diagnostic targets having a diameter of approximately 50 μm have been fabricated by this process with metal layers of copper, titanium, and aluminum. Other metals are not expected to present unusual difficulties. Metal layers are usually a fraction of a micrometer thick, typically 0.3 μm, but much thinner layers can also be coated.

The developed procedure is now routinely used to fabricate laser fusion diagnostic targets.

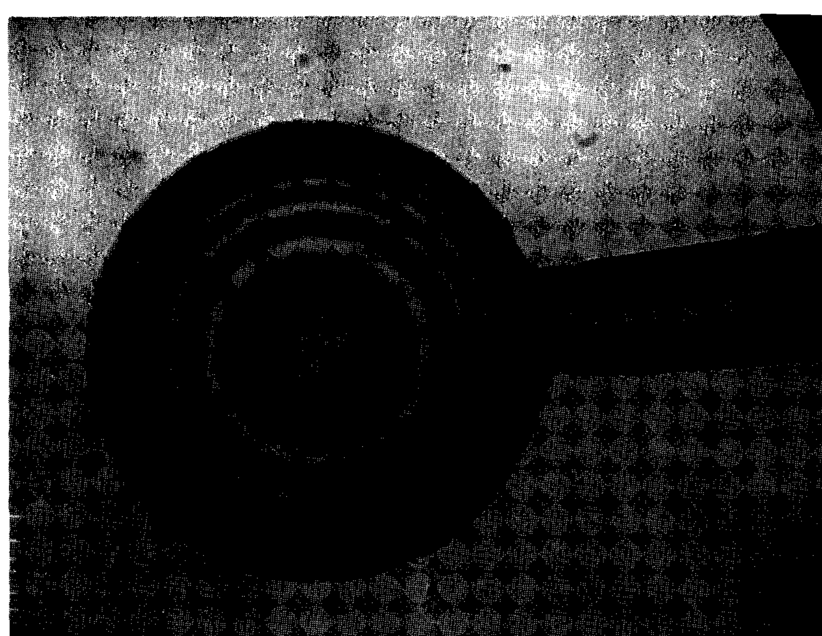


Fig. 10
Optical interferogram of parylene shell fabricated by the present procedure.