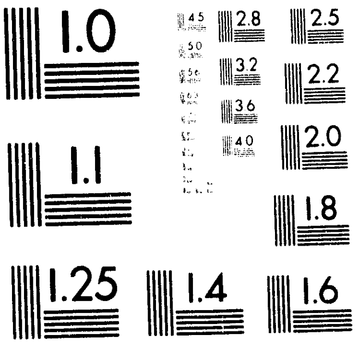
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ABSTRACT

Event: Poster Session of the Ninth Target Fabrication Specialists' Meeting

General Topic: Polymeric Thin Films

Title: Techniques for Producing Free-Standing Thin Films on Frames

The procedures of vapor-deposition polymerization, spin coating and orientation-dependent etching have been employed to make free-standing thin films of Parylene-N, Parylene-D, polystyrene, polycarbonate and perfluoro-dimethyl-dioxole/tetrafluoroethylene copolymer (Teflon® AF-1600). The polymeric materials were vapor-deposited or spin-coated onto substrates of polished single-crystal silicon (wafers) and removed on frames of various shapes and sizes after application of adhesive and an etching process using potassium hydroxide. Thicknesses range from 2000Å to 12000Å.

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S Y N O P S I S

Spin coating provides a convenient way to produce thin films of various polymeric materials on a variety of substrates. Experimenters in target physics have a need for free-standing polymeric thin films within frames that may range in thickness from 1000 Ångstroms up to two microns. The films typically must be pinhole-free and as uniform as possible.

Glass as a substrate material is problematic in that slides are generally not clean, even directly from the box in which they are shipped. Another possibility for a substrate material is highly polished single-crystal silicon, available and widely used in the form of wafers by the microelectronics industry. Wafers called "monitor" wafers, used for judging the quality of a process or for checking a piece of equipment, are suitable for fabrication of pinhole-free thin polymeric films either by spin coating or vapor deposition and subsequent removal by means of liftoff in water. They are relatively inexpensive and remain clean if one is careful not to allow dust to enter the box in which they are shipped, and if the time the box is left opened is kept at a minimum. In addition, the wafers are physically separated from each other in the box, allowing easy manipulation with tweezers.

Wrinkle-free and uniform free-standing polymeric films are desired by experimenters. The uniformity of a film on a silicon wafer can usually be seen by the naked eye, since the

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highly polished surface is similar to that of a mirror. An excellent method for measuring the uniformity and thickness of films on silicon wafers before mounting on frames is ellipsometry. Multiple points can be non-destructively measured on the wafer surface, providing a thickness map of the film on the substrate.

Use of water as a medium to lift films off substrates and subsequently affix them to frames with adhesive is a common technique. However, it is somewhat difficult to fabricate wrinkle-free films within frames by this method. If the frames in question are adhered to the film that has been uniformly spin-coated or vapor-deposited onto the silicon wafer, orientation-dependent etching can be employed to slowly and mildly etch the silicon and silicon dioxide (on the surface of every silicon wafer) from underneath the polymeric film, allowing release of the frame with a free-standing film adhered to it. If the bond line between the frame and the film is secure, the film, now free-standing within the frame, should have close to the same mechanical characteristics as it had while on the wafer surface; in general, taut and wrinkle-free.

Orientation-dependent etching relies on potassium or sodium hydroxide dissolved in water at various concentrations and temperatures to etch silicon of a known crystalline orientation in a preferable direction. For the materials made in this study, the crystalline orientation of the silicon wafers was ignored, since the amount required to be removed for release of a frame with a film was so small.

The polymeric materials used for this study included Parylene-N and -D (vapor-deposited onto the wafers in a Parylene coating system), polystyrene (dissolved and spin-coated in toluene), polycarbonate (dissolved and spin-coated in bromoform) and perfluoro-dimethyl-dioxole/ tetrafluoroethylene copolymer (Teflon® AF-1600, dissolved and spin-coated in Fluorinert FC-43).

The frames were adhered to the films on the wafers with PRS-1201-Q polysulfide sealant (a two-component sealant containing polysulfides and lead oxide made by Semco). After curing of the sealant in a humid oven overnight at 60°C, the film was cut away from the outside of each frame around the entire perimeter with a blade to allow entry of etchant. The entire wafer was then immersed into the etchant (KOH dissolved in water, 0.25N) and left until release of the frames was achieved. The frames with their free-standing films were then rinsed in distilled water and allowed to dry and suitably stored in a dry environment.

An alternative approach would be to first coat the silicon wafers with some type of photoresist as a release layer (preferably colorless), overcoat the photoresist with the polymeric thin film, affix the frames to the film and etch the photoresist release layer from under the film with ammonium hydroxide after cutting the film at the perimeter of the frames.

The technique outlined above can provide an easy route to high-quality free-standing polymeric thin films within frames without the rigors of using water with its high surface tension as a medium for a wrinkle-free film. In addition, spin coating or vapor-deposition polymerization onto silicon wafers allows relatively easy and inexpensive production of uniform pinhole-free films.

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