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Fiber-Optic Sensor Would Monitor Growth of Polymer Film

Changes in thickness would be inferred from interference fringes.

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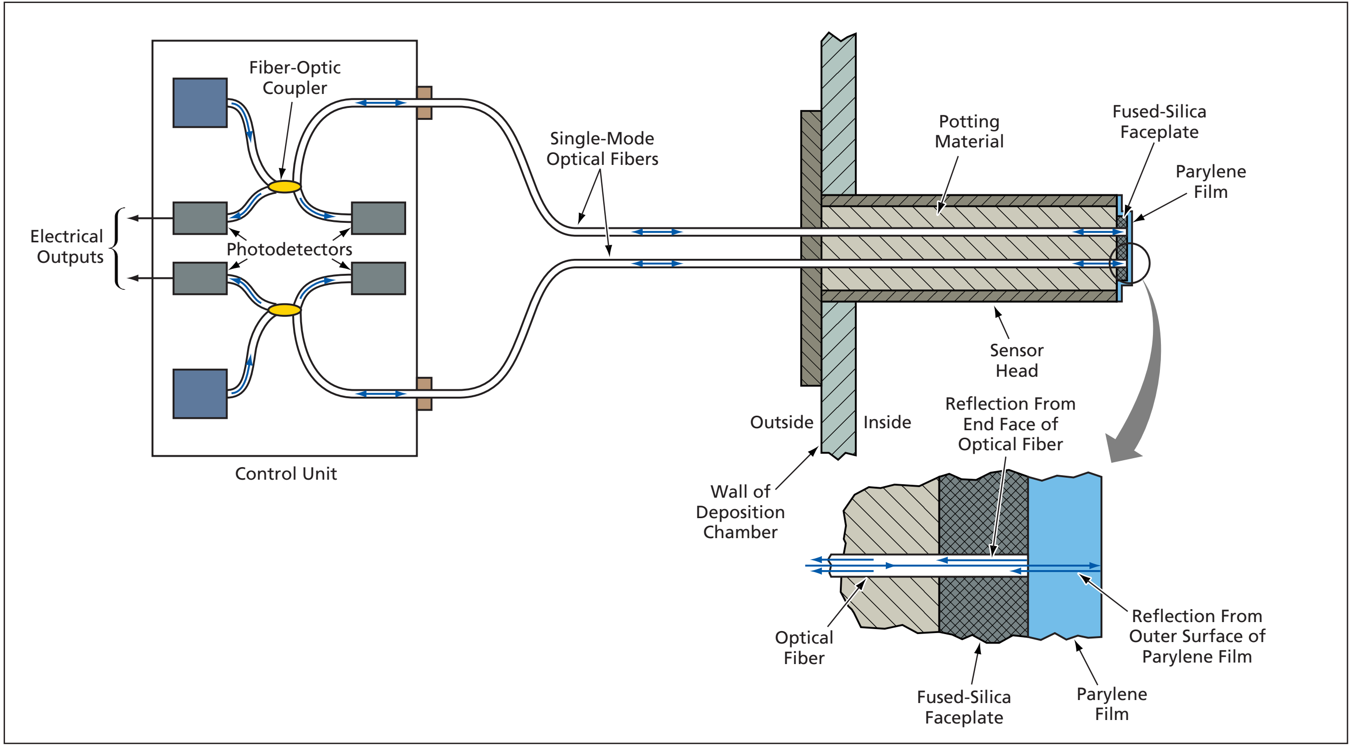
A proposed optoelectronic sensor system would measure the increase in thickness of a film of parylene (a thermoplastic polymer made from para-xylene) during growth of the film in a vapor deposition process. By enabling real-time monitoring of film thickness, the system would make it possible to identify process conditions favorable for growth and to tailor the final thickness of the film with greater precision than is now possible.

The heart of the sensor would be a pair of fiber-optic Fabry-Perot interferometers, depicted schematically in the figure. (In principle, a single such interferometer would suffice. The proposal calls for the use of two interferometers for protective redundancy and increased accuracy.) Each interferometer would include a light source, a fiber-optic coupler, and photodetectors in a control box outside the deposition chamber. A single-mode optical fiber for each interferometer would run from inside the control box to a fused-silica faceplate in a sensor head. The sensory tips of the optical fibers would be polished flush with the free surface of the faceplate. In preparation for use, the sensor head would be mounted with a hermetic seal in a feed-through port in the deposition chamber, such that free face of the faceplate and the sensory tips of the optical fibers would be exposed to the deposition environment.

During operation, light would travel along each optical fiber from the control box to the sensor head. A small portion of the light would be reflected toward the control box from the end face of each fiber. Once growth of the parylene film started, a small portion of the light would also be reflected toward the control box from the outer surface of the film. In the control box, the two reflected portions of the light beam would interfere in one of the photodetectors. The difference between the phases of the interfering reflected portions of the light beam would vary in proportion to the increasing thickness of the film and the known index of refraction of the film, causing the photodetector reading to vary in proportion to a known sinusoidal function of film thickness. Electronic means of monitoring this variation and the corresponding variation in phase and thickness are well established in the art of interferometry. Hence, by tracking the cumulative change in phase difference from the beginning of deposition, one could track the growing thickness of the film to within a small fraction of a wavelength of light.

This work was done by Michael Beamesderfer of **Goddard Space Flight Center**. *Further information is contained in a TSP* *(see page 1).*

This invention is owned by NASA, and a patent application has been filed. Inquiries concerning nonexclusive or exclusive license for its commercial development should be addressed to the Patent Counsel, Goddard Space Flight Center, (301) 286-7351. Refer to GSC-14757-1.



Portions of the Light Beam in each optical fiber would be reflected from opposite faces of the parylene and would interfere in one of the photodetectors. Variations in the photodetector output would be interpreted in terms of increases in the thickness of the parylene film according to well-known principles of interferometry.