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NASA TECH BRIEF

Holographic Analysis of Thin Films

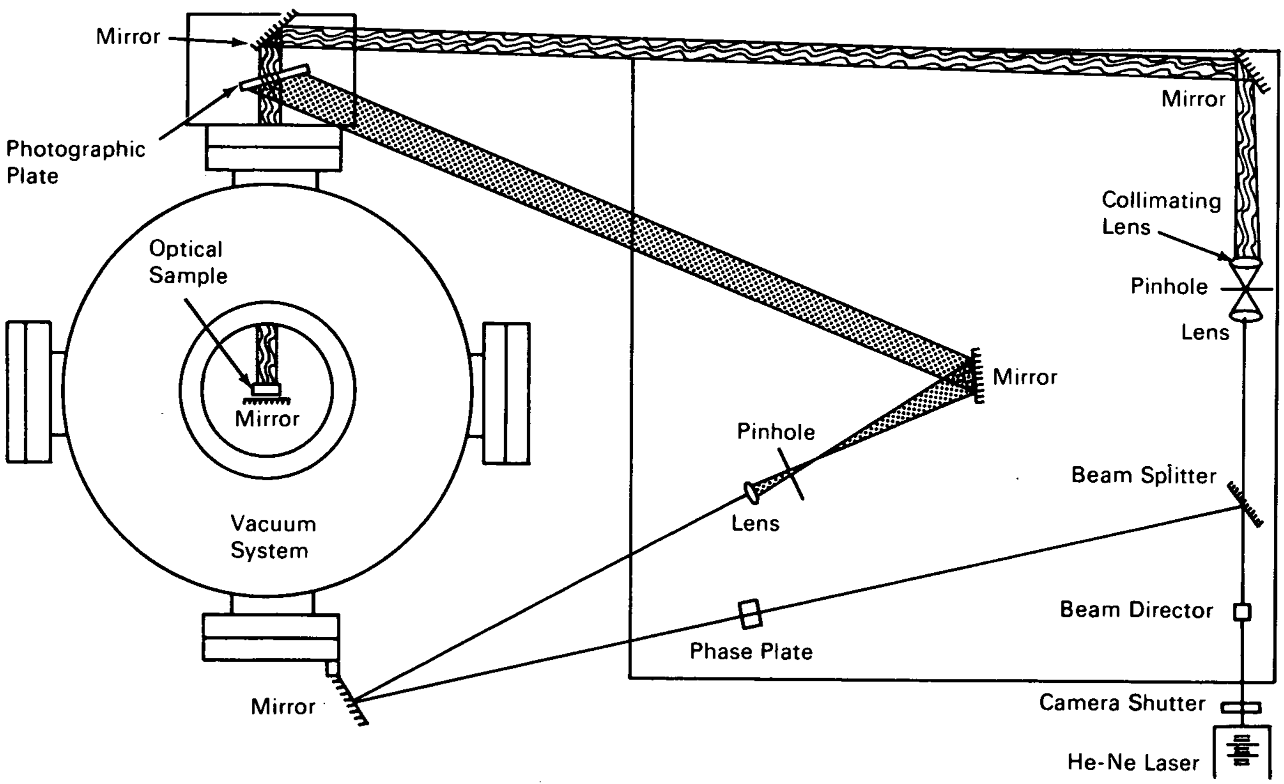

Diagram of Layout

A new technique for monitoring the deposition of films on surfaces, *in situ* on a real-time basis, reads both the thickness and the uniformity of the deposited film, where other techniques do not. The several types of vacuum-deposition monitors now available monitor either the change in reflectance/transmittance or the mass deposited.

In this new technique, the beam from a laser is split by a beam splitter (see fig.). The reference beam is reflected through a phase plate and a lens-pinhole assembly and is then directed by mirrors to a photographic plate. The other beam passes successively through a different lens-pinhole assembly, a collimating lens and an optical plate before striking the optical sample under vacuum. A portion of the light striking the sample is reflected back to the photographic film; and, by the placement of a mirror behind the sample, the light passing through the sample is also reflected back to the plate. The diameter of the object beam passing through the photographic film is about 1 in.;

(continued overleaf)

hence, only a 1-inch diameter circle on the film is overexposed. The result is a hologram; i.e., a recording, on photographic film, of interference patterns produced by coherent light, which in this case is the reflected and transmitted light.

In this configuration, a hologram is made with the optical flat clean. The photographic film is removed, developed, and returned to its original position. With the film in this position, the optical flat can be monitored by viewing through the hologram. A sample of material inside a vacuum chamber is heated to progressive vaporization; the resultant deposit on the flat is displayed throughout the hologram in the form of interference fringes yielding information on both thickness and uniformity. Sensitivity can be increased by a 180° rotation of the phase of the reference, using the phase plate. This change tends to cancel the clean-flat characteristics and thus enhances the film being formed. The phase may be rotated by other methods such as pressure or vacuum cylinders.

Measuring the intensities of the holographic images can yield the reflectance and transmittance coefficients, and thus the index of refraction, of the film. If the technique is used to monitor the surface of a quartz crystal, the mass deposited can also be measured. Thus, a complete, real-time picture of film deposition is possible. The technique measures both reflectance and transmittance samples with phase and/or amplitude films.

Believed to be new are (1) the application of holographic interferometry to thin-film monitoring *in situ*, (2) the phase rotation in connection with the object beam's passage through the film, and (3) the production of holograms from both reflectance and transmittance on one plate.

Notes:

1. This invention is in the conceptual stage only. At the time of this publication no model or prototype exists.
2. No additional documentation is available. Specific questions, however, may be directed to:
   Technology Utilization Officer
   Marshall Space Flight Center
   Code A&TS-TU
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   Reference: B70-10654

Patent status:

Inquiries about obtaining rights for the commercial use of this invention may be made to:

Patent Counsel
Mail Code A&TS-PAT
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