NASA TECH BRIEF
Marshall Space Flight Center

Optical Monitoring System

The problem:

One of the more difficult types of malfunctions to detect are those due to changes in the optical properties of windows, lenses, and mirrors. Films of dust, oil, and other contaminants can be subtle enough to evade detection by the naked eye, and yet, significantly affect the operation of sophisticated devices that depend upon sensitive optical components. When continuous detection of such optical errors is required, as is the case with spacecraft instruments or as might be desirable with astronomical telescopes and during the production of many kinds of optical devices, the design of a suitable monitoring system becomes an even more complex task.

The solution:

A newly developed instrument can measure optical transmission, reflectance, and scattering. This information can then be used to identify changes in optical properties or deviations from required optical standards. This device consists primarily of a monochromatic source, a photo detector, a transfer mirror, and a hemi-ellipsoid. The system is currently designed for laboratory use, but will ultimately be automated for unattended use in other environments.

How it's done:

The intensity of a transmitted or reflected beam of light is measured for each sample. The transmittance, reflectance, or scattering is then determined by comparison with the incident beam as in conventional spectroscopy. The optical design of the instrument is shown in the figure (overleaf).

Monochromatic light is focused on the sample by a toroidal mirror. Light reflected from the sample comes to a focus at the surface of the hemi-ellipsoid. This allows the aperture through which the light passes to be as small as possible. The reflected light is measured by a phototube, placed as shown in position A.

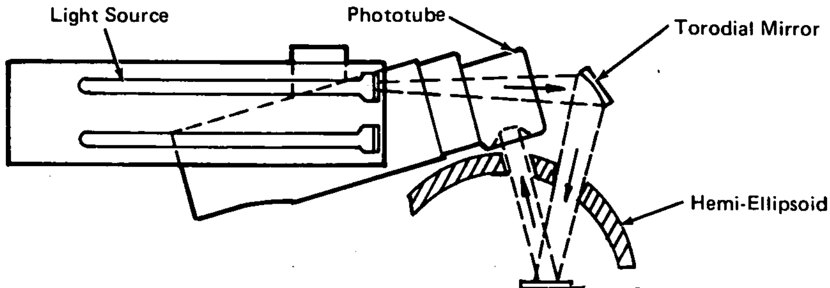
To measure scattering, the phototube is moved to position B. In position C, the phototube is placed behind the sample to measure the transmitted light. When the sample is removed, and with the phototube in position C, the incident intensity of the light can be measured.

The ultraviolet, monochromatic light sources used in this version of the system are obtained from RF excited krypton and mercury lamps (1236 and 1849 Å, respectively). The photo detector system uses a commercially available photomultiplier with a magnesium fluoride window, a cesium iodide cathode, and 18 stages of amplification. This system may also be equipped with quartz crystal microbalance gages to determine the quantity of contaminant deposited on the sample surface.

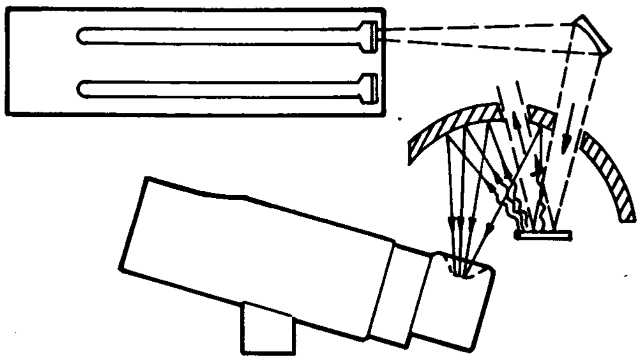
Notes:

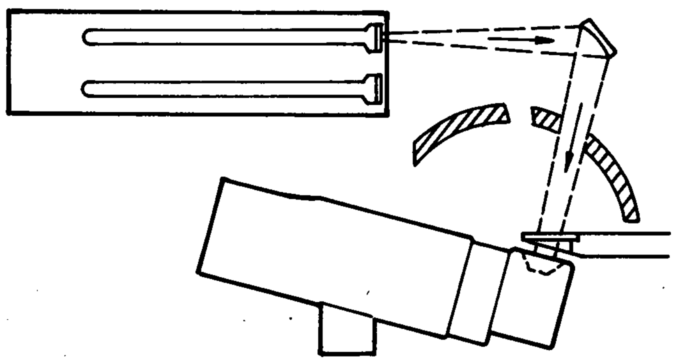
1. In thin film technology this system might be used to measure optical properties of the film and correlate them with the film mass, or to monitor film thickness.
2. Requests for further information may be directed to:
   Technology Utilization Officer
   Marshall Space Flight Center
   Code A&PS-TU
   Marshall Space Flight Center, Alabama 35812
   Reference: B73-10050

(continued overleaf)



Phototube In Position A
Reflectance Measurement


Phototube In Position B
Scattering Measurement


Phototube In Position C
Sample Removed

Patent status:

NASA has decided not to apply for a patent.

Source: J. T. Neu, E. H. Wrench,
M. G. Fox, and H. Laue of
General Dynamics Corp.
under contract to
Marshall Space Flight Center
(MFS-21692)