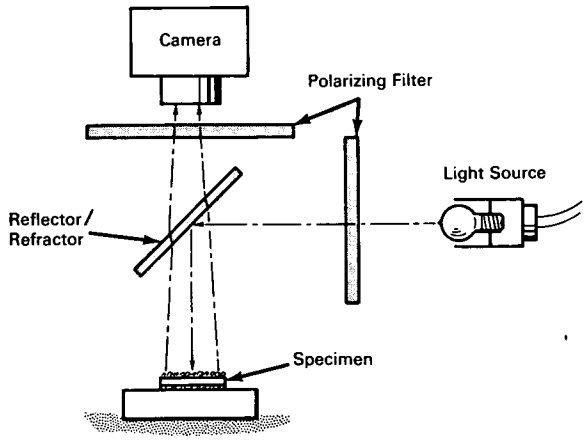
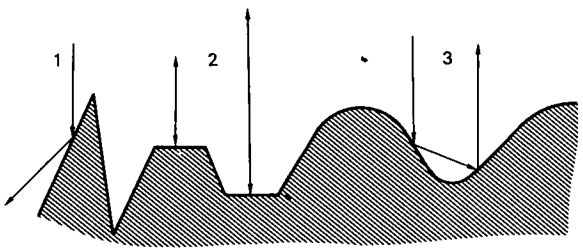
NASA TECH BRIEF

Fatigue Zones in Metals Identified by Polarized Light Photography





The problem:

While fatigue zones in metal where surfaces fracture are often evident to the naked eye, particularly under properly oriented light, photographing or measuring these zones has proven difficult.

The solution:

A polarized light technique that clearly defines the fracture surfaces for measuring and photographing.

How it's done:

White light is passed through the vertical polarizing filter whose plane of polarization is parallel with the upper edge of the reflector/refractor. Light passed by this vertical filter is plane-polarized, vibrating at right angles to the plane of the illustration, and is reflected downward without rotation onto the surface of the fracture specimen. Upon striking the surface, each ray in the plane-polarized beam will behave optically in one of three ways:

(1) If the surface at a particular prominent point is met at a very low angle of incidence, the light ray will be scattered outside of the optical system.

(2) If the surface is met perpendicularly, at a flat spot, the light ray will be reflected back into the optical system without rotation.

(3) If the surface is met obliquely at a large angle of incidence, the light ray is reflected at least twice and suffers some change in direction as well as a change in polarization from plane to elliptical.

Following reflection from the specimen surface, the rays represented by items 2 and 3 in the right figure are refracted without rotation through the reflector/refractor to impinge on the horizontal polarizing filter. Because this filter's plane of polarization is 90° from that of the vertical filter, all rays unrotated at the specimen surface (as in item 2) will be extinguished. In contrast, the light rays that undergo multiple reflections from oblique surfaces (as in item 3) become elliptically polarized and result in transmittal of two planar segments of each light wave 180° apart through the horizontal filter into the camera system.

(continued overleaf)

The plane-polarized light obtained from elliptically-polarized light is used to obtain photographs by the crossed-polar technique. The degree of shading or contrast obtained is apparently a measure of the relative strength of plane-polarized rays and elliptically-polarized rays from each photographically discrete zone in the fracture surface and which, in turn, then becomes a measure of the relative statistical distribution of reasonably flat surfaces and variously oblique surfaces.

Note:

Inquiries concerning this innovation may be directed to:

Technology Utilization Officer
Western Support Office
150 Pico Boulevard
Santa Monica, California 90406
Reference: B67-10082

Patent status:

No patent action is contemplated by NASA.

Source: Frank D. Walsh
of The Boeing Company
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