M41
SURFACE FINISH INTERFERENCE

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There is an ever increasing requirement in industry and in basic materials research for equipment capable of the non-destructive measurement of surface finish characteristics such as length, slope and depth of surface features. The surface finish interferometer offers such a capability allowing immediate visual estimation of surface deformation down to 1/20th of the wavelength of green light 546 nm i.e. about 27 nm. An even higher accuracy of measurement may be achieved by the evaluation of fringe photographs down to about 1/200th of the wavelength of green light i.e. about 2.7 nm.

PRINCIPLE

The microscopically enlarged surface of the specimen is crossed by a series of equidistant interference fringes the spacing of which correspond to a height change of exactly $\frac{1}{2}$ of the wavelength of the light employed, 273 nm with a precision line 546 nm interference filter. The deformation of the fringes as they cross any fine surface features such as grooves, ridges or pits is an exact measure of the height or depth of the features.

This principle finds application in a great number of cases :

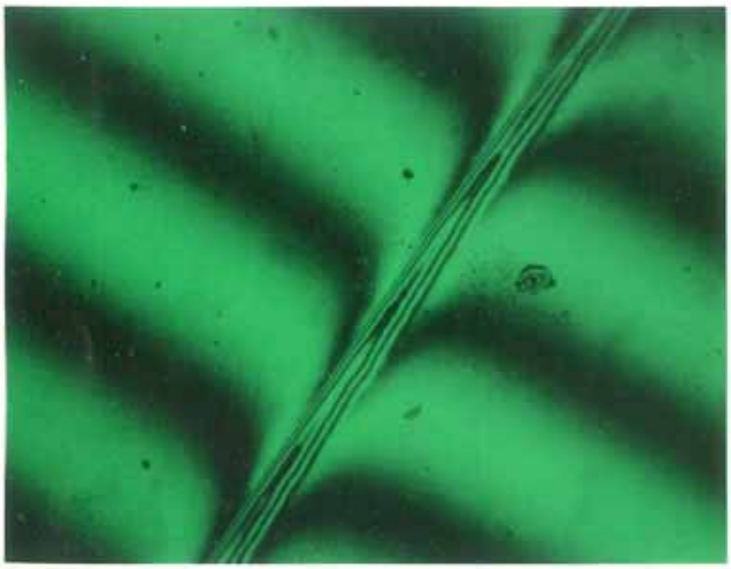
Flaws on finished surfaces — ball bearings, bores, paint, glass, ceramics etc.

Hone and other mechanically produced angles — razor blades etc.

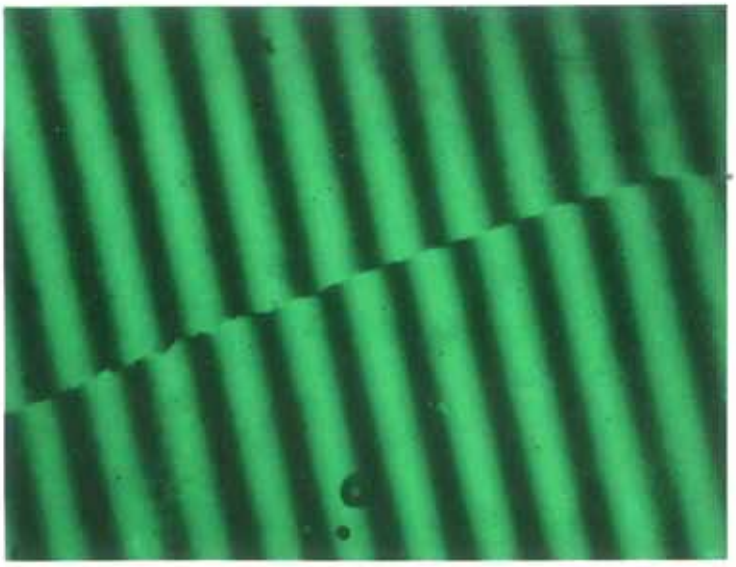
Micro circuitry inspection.

Film thickness — optical coatings, semi-conductors etc.

Surface structure studies — minerals, ores, metals, biological material etc.



Fringes on scratch in stainless steel. Both the groove depth and contour and the surface "piling" around the groove are plainly measureable.



Fringes on optical step coating showing obvious fringe shift.

EQUIPMENT

All four interference objectives may be fitted together into the standard quadruple centring objective changer on the M41 Photoplan incident light illuminator.

The tilting stage is interchangeable against the standard M41 stages on a dovetail carrier. Any adjustments to fringe width and orientation are made by manipulation of the three screw operated legs. The stage is fitted with a sprung loaded specimen support so that specimens in standard metallurgical mounts of between 1" (25.4 mm) and 1.25" (35.5 mm) diameter and 1" (25.4 mm) height may be accommodated parallel to the stage top plate. The two magnetically interchangeable top plates have a free aperture of 22 mm. Other specimens, with a maximum height of 24 mm should be mounted on an interchangeable solid flat top stage plate. The specimen is traversed by a smooth gliding movement of 0.8" (20.3 mm) diameter covering very nearly the whole free aperture.

The surface finish interferometer is an extremely sensitive instrument and should always be mounted in as vibration free a location as possible. It is advisable, particularly when employing photography, to mount the M41 photoplan on the special shock absorbing base which will effectively eliminate all but the most persistent vibrations.

Interchangeability

Immediate interchange may be made between the interference equipment and alternative objective changers allowing other incident light techniques to be undertaken with minimum specimen disturbance. Alternative techniques include incident light bright field, dark ground, Nomarski contrast, micro hardness testing, and polarizing.

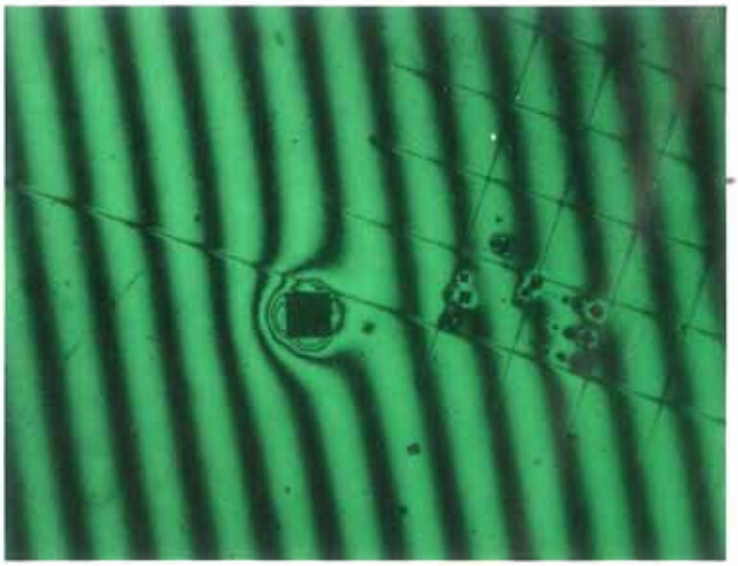
Light Sources

The standard range of M41 Photoplan light sources may be employed. It is usually adequate to use the tungsten halogen 12 volt 100 watt light source together with a 546 nm precision interference line filter of 32 mm ⌀. The filter is contained in a detachable holder which fits onto the incident illuminator. Filter removal is readily accomplished for change over to white light operation.
When working mainly with low reflectivity materials it is advisable to employ the 50 watt mercury vapour lamp or the high pressure mercury vapour lamp HBO 200.

Photography

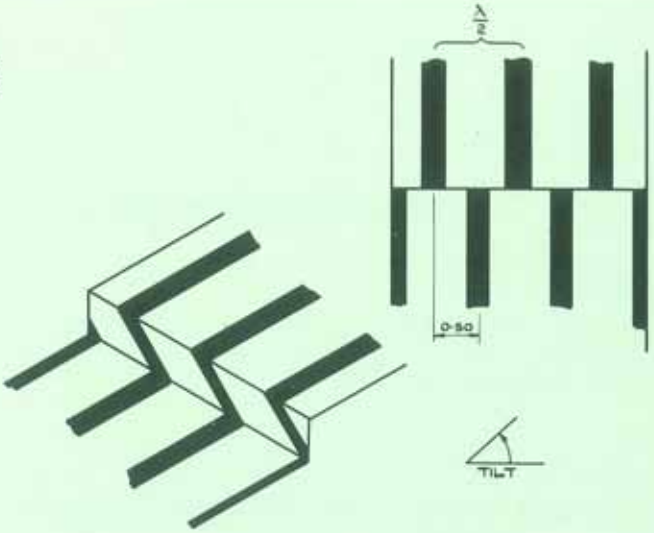
All standard M41 Photoplan camera equipment may be used thus permitting photography on all camera formats from 35 mm to 4" × 5" including the range of Polaroid backs.

Microcircuit with narrow spaced fringe pattern.

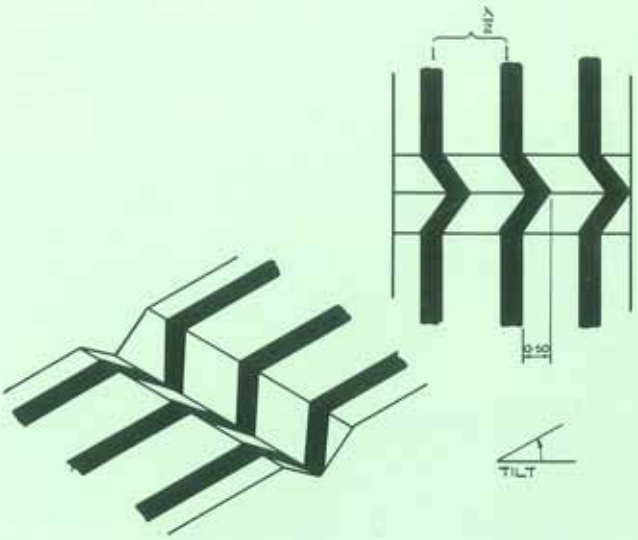


Micro hardness indentation on stainless steel test specimen.

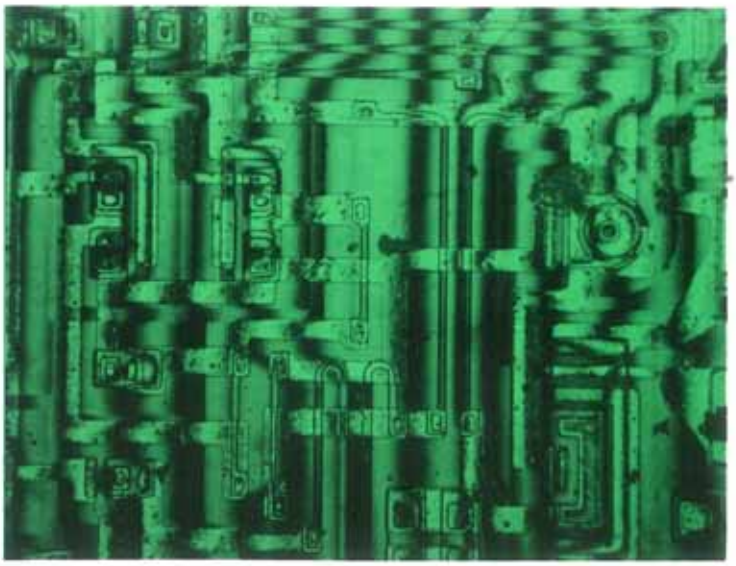
Fringe deviation pattern formed by a surface step. The layer thickness is clearly seen as the ratio of fringe width to fringe deviation.



Fringe deviation pattern formed by a wedge shaped groove. The depth is clearly measurable as the ratio of fringe width to fringe deviation.



Ball bearing showing severe surface damage and lack of sphericity.



Microcircuit with wide spaced fringe pattern.

All photomicrographs in this brochure have been taken on Polaroid type 42 film with the J35 automatic exposure unit. All camera framing and focusing is accomplished with the binocular viewing head.

OPTICAL METHOD

Two basically differing balanced interferometer systems are employed. In each system the complete interferometer including the beam splitter and combiner and the reference surface are contained within the microscope objective itself.

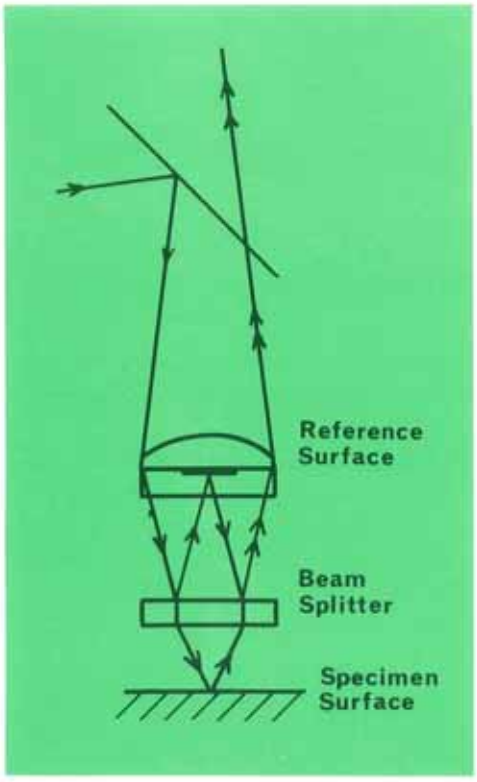
40x Objective

The 40x objectives employ a modified Mirau interferometer system. The reference surface is placed centrally on the objective front lens. The action of beam splitting is performed by a partially reflecting surface on a cover plate beneath the objective front lens. It will be seen that an illuminating ray first strikes the semi-reflecting surface where a proportion is reflected upwards illuminating the reference surface. After a further reflection from the semi-reflecting surface the ray passes to the eyepiece. The other fraction of the light passes through the semi-reflecting surface to the specimen and then back up to the eyepiece. Destructive interference occurs when the two beams are 180° out of phase.

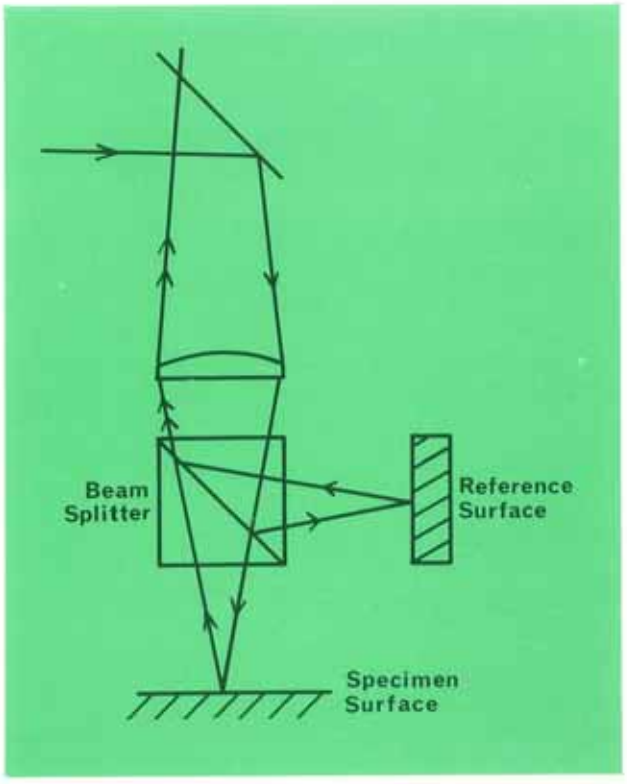
10x Objective

The 10x objectives, based on the Michelson principle, contain a prism beamsplitter beneath the objective front lens together with a suitable reference surface. Interference occurs in exactly the same manner as with the 40x objective.

Each type of objective is available fitted either with a low reflectivity reference surface for use with materials of low reflectance such as glass, dielectrics etc. or with a high reflectivity reference surface for use with materials of high reflectance such as polished metals, mirror coatings etc.



40x Modified Mirau interferometer system



10x Michelson type interferometer system

M41 PHOTOPLAN ACCESSORIES FOR SURFACE FINISH INTERFERENCE

M412560 Tilting stage for surface finish interferometer

M024842 10x Low reflectivity interferometer objective
M024812 10x High reflectivity interferometer objective

M024942 40x Low reflectivity interferometer objective
M024912 40x High reflectivity interferometer objective

M413503 Filter carrier for 32mm Ø filters
M322280 Precision interference line filter 32 mm Ø 545 nm
M413800 Shock absorbing microscope base

VICKERS LTD.

VICKERS INSTRUMENTS

HAXBY ROAD
YORK YO3 7SD
Telephone: 09-04 24112
Telegrams: Coordinate York

PURLEY WAY
CROYDON CR9 4HN
Telephone: 01-688 3845
Telegrams: Optivorum Croydon