# optics is light work

The OPTICS IS LIGHT WORK column is an outgrowth of the OSA-sponsored Optical Fabrication and Testing Workshops. It is the intent of the Workshops to communicate technology and practice in the fields of optical manufacture and testing to opticians and optical engineers. Those attending the Workshops generally agree that the periodic meetings are fulfilling these goals; however, the audience that can be reached is small, perhaps 1200 people once a year. By publishing in *Applied Optics* a fabrication-and-test-oriented column, a far larger audience can be reached twelve times a year.

This column is intended to be a means of timely exchange of specific tips or recipes to make the life of the optician or technician easier and more fruitful. Reports of experiences with new products and the application of familiar products in unique ways are encouraged. Transfers of other areas of technology to the solution of optical fabrication and testing problems would be welcomed.

Material for this column is solicited from all workers in the field of optics and may be submitted to either editor. Limit your note to 500 words (2 double-spaced typed pages) and one illustration, just enough to get across one specific idea or method.

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## Interferometers eliminate test plates during fabrication

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The typical method of testing optical components during fabrication is with test plates. This is especially true for the testing of spherical surfaces. Test plates are used because they provide the optician with information on both the surface figure and radius of curvature. By using a Fizeau interferometer with the optical axis oriented vertically and making a small investment in tooling it is possible to remove the test plates from the shop floor. This increases the life of the test plates, provides the optician with easy to view fringe patterns, tests the optical surface without contacting inside of the clear aperture, and speeds up testing. The use of this technique reduces production cost and increases product quality.

This method is most applicable to concave and convex optical surfaces that are blocked singly. Multiple-element blocks with long radii do not lend themselves well to this technique although in some cases they can be tested.

The first step is to fabricate a master with the same mass, radius of curvature, and diameter as the optic to be manufactured. The master can be qualified against a test plate or using an interferometer with radius measurement capability (a spherometer can be used to determine radius if its accuracy is sufficient for your application). The mass should be matched to the mass of the element and blocking tool because you will be testing the part while still blocked. You will want any stage deflection due to the mass of the part to be equivalent to the deflection caused by the master. Surface figure should be better than the component that you are manufacturing.

The second step is to fabricate the lens holding tool. The tool should be kinematically designed to hold the lens by contacting the optical surface at three equally spaced points outside the clear aperture. The tool should also provide a centering location that is accurate enough to prevent the test piece from sliding off of the mounting points and falling. Remember, gravity will be used to hold the lens in place so no fancy clamping mechanism is required. This tool should be designed to mount rigidly to the adjusting stage supplied with the interferometer. A possible tool design is shown in Fig. 1. The adjusting stage should have the ability to move

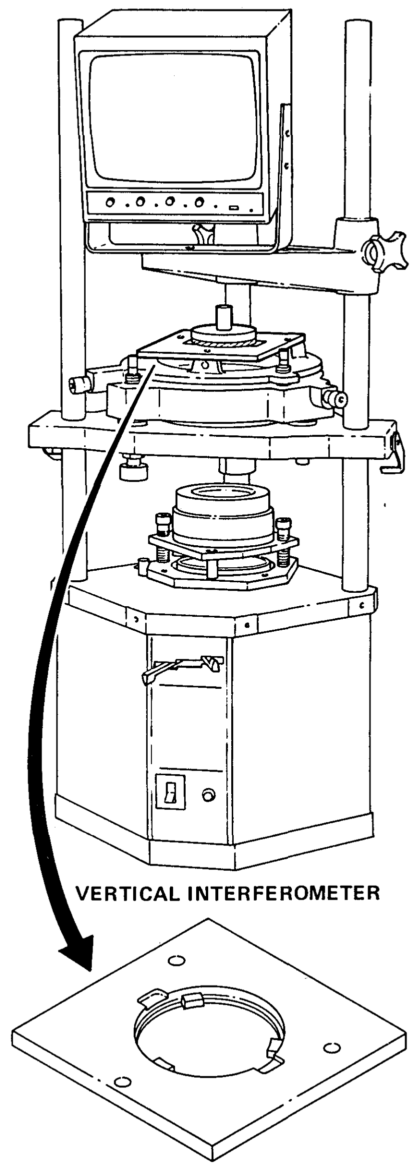


Fig. 1. Vertical interferometer and lens holding tool.

over a large range vertically and provide for fine adjustment in the vertical and both horizontal axes.

When you are ready to use the interferometer, mount the tool on the adjusting stage, select the proper reference optic, and place the master in the mounting tool. Adjust the stage in height and the two horizontal axes to obtain a fringe pattern with four or five straight fringes and remove the master. For testing during fabrication it is a simple matter to remove the lens and blocking tool from the spindle and place them on the lens holding tool. Because a three-point kinematic mounting system is used, the curvature of the fringes represents the radius error, and the fringe irregularity represents the figure error. This pattern is identical to the pattern that the optician observes using a test plate, but it is of much higher quality and easier to observe. This makes training the optician in fringe pattern interpretation unnecessary if they are familiar with test plates. The interferometer also provides a scotopic view eliminating the viewing distortion introduced by test plates.

Some new interferometers due to their kinematic design do not require vibration isolation, and, therefore, they can be easily moved between work stations in the optical shop. This flexibility in conjunction with noncontact testing and the ability to make hard copy records of the interferogram can contribute to a significant improvement in optical shop productivity.

# RAPID COMMUNICATIONS

This section was established to reduce the lead time for the publication of Letters containing new, significant material in rapidly advancing areas of optics judged compelling in their timeliness. The author of such a Letter should have his manuscript reviewed by an OSA Fellow who has similar technical interests and is not a member of the author's institution. The Letter should then be submitted to the Editor, accompanied by a LETTER OF ENDORSEMENT FROM THE OSA FELLOW (who in effect has served as the referee and whose sponsorship will be indicated in the published Letter), A COMMITMENT FROM THE AUTHOR'S INSTITUTION TO PAY THE PUBLICATIONS CHARGES, and the signed COPYRIGHT TRANSFER AGREEMENT. The Letter will be published without further refereeing. The latest Directory of OSA Members, including Fellows, is published in the July 1987 issue of Optics News.

## Coherent optical correlator using a deformable mirror device spatial light modulator in the Fourier plane

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A coherent optical correlator system using the Texas Instruments deformable mirror device (DMD) spatial light modulator as a Fourier plane phase-modulating filter has been constructed and demonstrated. The DMD functions in this system as a electronically addressable phase-only matched filter.[1-3] The experimental results obtained using this system agree closely with computer simulations of operational performance based on a model developed for the response characteristics of individual DMD elements. We present here some of the experimental results obtained with the DMD employed as a binary phase-only filter and a comparison of these results to the computer simulation. We also comment on the application of the DMD as an analog phase-only filter.

The optical system used in this work is shown in Fig. 1. The system is a classical 4-$f$ optical processing system with all lens focal lengths equal to 50 cm. Coherent illumination for the system is provided by a He–Ne laser operating at 632.8 nm. The input image for this experiment is a photographic transparency consisting of typewritten text. The DMD light modulator placed in the Fourier plane is a 128 × 128 array of inverted cloverleaf deformable mirror elements with element spacing of 50.8 $\mu$m.[4] The DMD is addressed electronically under computer control with element deflection patterns stored in computer memory. The computer controlling the devicer is an IBM compatible personal computer, and the computer interface hardware presently available allows the DMD to be addressed with up to 180 separate filter patterns per second. Frame rates for 128 × 128 array devices as high as 8 kHz are possible. The output image at the correlation plane is detected by a high resolution (785 × 480 element) CCD video camera.

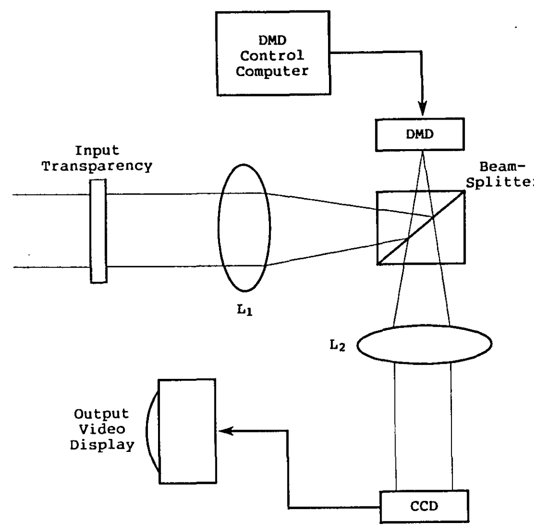


Fig. 1. Diagram of the DMD correlator system.

The basic optical characeristics of the DMD light modulator have recently been described.[5] The results of that study indicated that the device has a large number of active diffraction orders and that the optical response characteristics, in particular the intensity contrast ratio, vary from order to order. As part of the experimental work reported in this Communication, we have also demonstrated active phase modulation for the different diffraction orders. One impor-