

American Metal Market

December 9, 1985

Fiber Optics Being Used to Create Holograms to Study Stress Effects

Development Work at U. of Wis.-Milwaukee Projects
3-D Images to Scan Aero, Submarine Parts, Circuitry

By LAURI GIESEN

MILWAUKEE—A technique which uses fiber optics to create holographic interferometric images is being developed by a University of Wisconsin-Milwaukee researcher to study stress effects on such objects as aircraft wings, submarine components, composite plies and computer circuit boards.

John A. Gilbert, professor of mechanical engineering at the University of Wisconsin-Milwaukee, noted holography has been used for some time to study stress although traditional methods have usually utilized bulky cameras and lenses which were not effective in studying difficult-to-reach areas.

Gilbert has been trying for several years to combine fiber optics, which gives access to images from hostile and remote areas, and holography, which projects three-dimensional images to be analyzed. He said improvements in the development of the optic fibers have permitted the technology to offer a practical solution for studying the effects of stress and temperature on a wide range of materials and components.

Results of such studies would be valuable in helping engineers make design and material changes to prototype models to avoid failure due to stress.

The fiber optics that Gilbert is utilizing project laser light through the end of a fiber and illuminate the area under study. An image of the area is then transported back through the fiber to a recording station. Regardless of the type of component studied, heat or pressure can be applied to the area and the changing images can be studied to note troubled areas.

Gilbert said computer-aided design stations also can be used with this process to display the images picked up by the laser system and help designers analyze the component and make changes.

Advances in both the fibers used to illuminate the area and those used to transmit the images back to the holographic film have been made by optical fiber manufacturers and have improved the accuracy of information received, Gilbert said.

Gilbert's research is receiving funding of over \$500,000 from the Army Research Office, Research Triangle Park, N.C., as well as funding from AT&T's Bell Laboratories, Murray Hill, N.J., and Allen-Bradley Co., Milwaukee.

Although an application of the technique that has received considerable attention is for analyzing the effect of heat on computer circuit boards, Gilbert said the technology could also be important in studying new aircraft, submarine and tank designs and could provide important information on composite properties.

"The properties of materials like steel and aluminum are well-known. But the properties of composites are dependent on the reinforcement they get. Also, the properties won't always be the same if you measure them in from different directions," he said, noting he hopes the holographic technique will be able to generate enough data on composites to develop better information on those properties.

Donald Matthys, a professor of physics at Marquette University in Milwaukee, who joined Gilbert's research efforts to help develop an automated fiber-based recording system, said the research has reached the point where the application of holography appears feasible but automation is needed to make it practical for industrial use.

In the analysis of circuit boards, Matthys said holography appeared to provide a too complex series of data to be practical. Efforts are now underway to develop the computer software

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Holograms Scan Components

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programs to digitize the images received so that computers can aid in analytical decisions about the boards' properties.

Matthys said images of unheated circuit boards would be taken and, for comparison,

images of circuit boards exposed to various temperatures would be taken to note the warping, twisting or other thermal deformation. Computer analysis would then be able to compare the images received and allow engineers to propose new

designs that would be more conducive to specific variations in heat.

Edward Saibel, Charlotte mechanics branch chief for the engineering science division of Army Research Center, said the Army was funding Gilbert's research because it is felt it could be utilized by a number of defense manufacturers in aircraft, helicopter or other machinery designs. Also it would be particularly important in studying fixed wing structures, he said.