sol CHARACTERIZATION USING AOTF POLARIMETRIC HYPERSPECTRAL IMAGING

Li-Jen Cheng *
Jet Propulsion Laboratory,
California Institute of Technology, Pasadena, CA 91109

Guann-Pyny Li
University of California, Irvine
Irvine, CA 92715

Deyu Zan
MetroLaser, inc.
Irvine, CA 92715

'l-his paper presents results from a preliminary study of using an acous(o-optic tunable filter (AOTF) polarimetric hyperspectral imaging (P} II) system to perform SOI characterization. Functionally, AOTF is a fast programmable, high-resolution spectral bandpass filler with polarization beamsplitting capability. With proper optics and focal plane arrays, one can usc it to build an instrument capable of taking images as a function of wavelength and polarization. Recently, JPL developed an AOTF-PHI prototype system and have successfully done a number of outdoor field experiments for evaluating the application potential for remote sensing. Wc have used the same system to study white light interference patterns of a thinned SOI sample from Hughes. Results illustrate thatAOTF-P111 can not only give both silicon and silicon oxide layer thickness maps, but also provide detection and mapping of imperfections in the SOI structure. Figure 1 gives a photo and optical configuration of the system.

Figure 2 shows two interference images. Onc was taken at the wavelength at which most pixels were at the constructive condition and the other at the destructive condition. The images revealed clearly that the layer thickness was not uniform across the wafer. in addition, the images revealed faint concentric rings around the wafer center which could be induced during grinding and polishing.

The wavelength dependence of the interference signal at onc point will provide information of layer thickness al that point. The variation of the dependence as a function of position will give a thickness map. in order to determine the thickness from the measurement, a model of the interference was created. Using the model, wc arc able to determine the silicon thickness and its variation along the layer. Figure 3 gives a computed spectrum (top) using silicon layer thickness of 720 nm and oxide layer thickness of 1000 nm and a measured interference spectrum (middle), The similarity of these two spectra determines the thickness of the layer at the location. Figure 3 (bottom) also gives interference spectrum of another location shifted toward the short wavelength about 22 nm in the spectrum scale with respect to the previous one. This shift corresponds a reduction of the thickness about 45 nm.

A reduction of the interference signal is an indication of the existence of imperfect ions in the. The spectrum at the bottom of Figure 3 has interference signal which is only about a half of that of the spectrum at the middle. Our modeling did show that the interference signal changes with thickness, but with a small variation being only about 5% or less within the measured thickness range. The observation of 50°/0 percent reduction reveals that the reduction is duc to the existence of optically active imperfections in the structure. This observation illustrates the capability of AOTF-PHI for detecting and mapping imperfections in the SOI structure.

Figure 4 gives interference signal images of the wafer with two polarizat ions orthogonal to each other, computed from observed interference patterns in the wavelength range of S 10-560 nm. Wc defined that the interference signal is the difference between the maximum signal and the minimum signal within the wavelength range. The left image was computed from the data taken with polarization perpendicular to the light incident plane. Wc noted that the interference signal image were significantly different from the interference patterns observed directly, because the interference signal image relates to the imperfection distribution, whereas the interference pattern is duc to thickness variation, The images of two polarizations have observable differences, illustrating that polarimetric measurement is important for characterization of imperfections.

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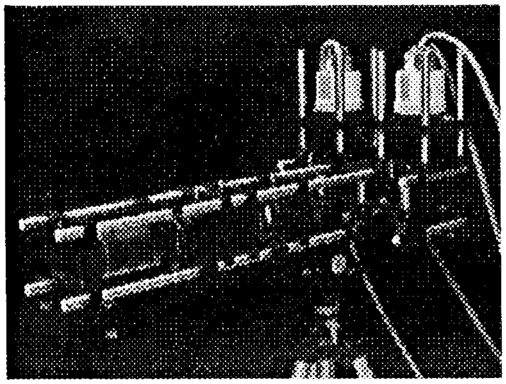

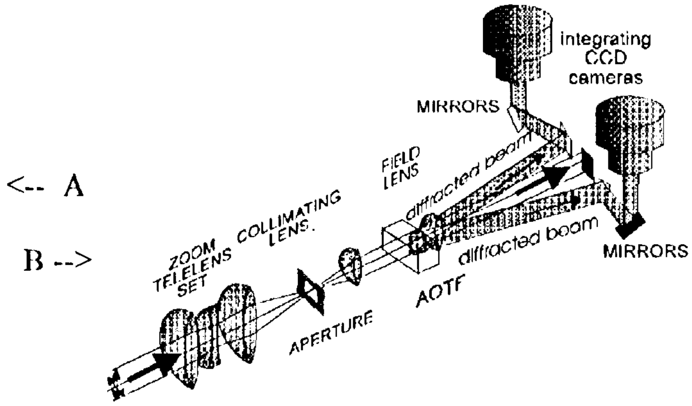

Figure 1. Photo (A) and optical configuration (B) of the AOTF-PHI prototype system used.

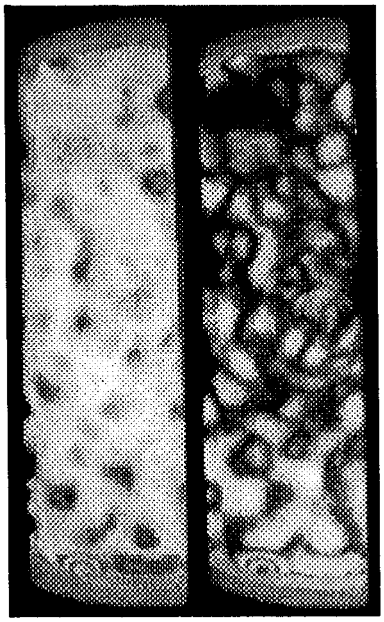

Figure 2. Interference images at 626 nm (left) and 601 nm (right). The image at the left was at a constructive interference for most points and that at right at a destructive interference.

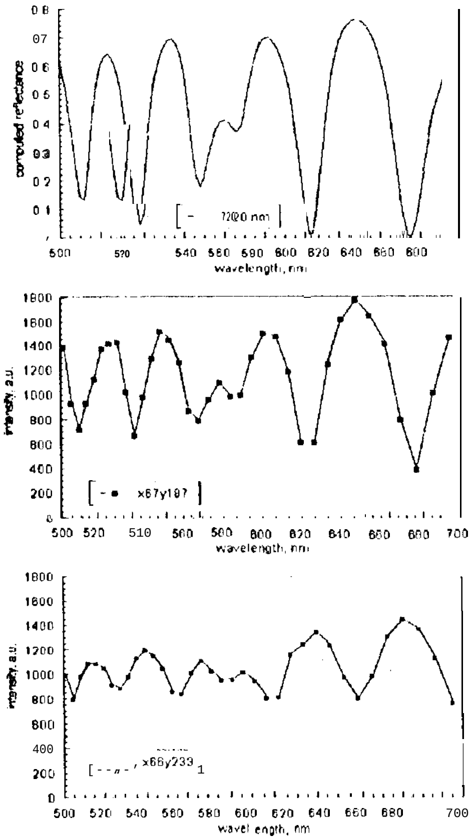

Figure 3. Top: Computed interference spectrum using silicon layer thickness of 720 nm and oxide layer thickness of 1 micron. Middle: Measured spectrum of a location with features similar to the computered one. Bottom: Measured spectrum at another location, showing pattern shift due to thichness change and amplitude reduction due to imperfection.

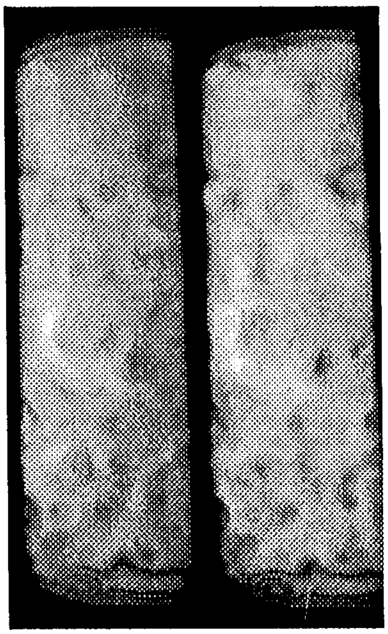

Figure 4. Interference signal images generated from interference pattern image data in the wavelength range of S09-SS9 nm with polarization perpendicular to (left) and within (right) the incident plane.