Influence of overlayers of photodetectors on their optical properties

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Most photodetectors are known to have layered structures on their photosensitive surfaces: for example, SiO2 on Si for a silicon photodiode, Au on GaAsP for a GaAsP Schottky photodiode, Al2O3 on Al for an aluminum vacuum phototube. Response of such photodetectors are closely related to the optical properties of their surface, because detector response in the case of a photodetector using internal photoelectric effect, for example, is proportional to the transmittance of overlayers into the sensitive region. The rest of the photons are lost due to reflection at the surface and absorption in a dead layer. Therefore, even a single overlayer structure on a detector surface may play a significant role in its photoresponse.

In the present study, we have characterized some photodiodes such as silicon photodiodes in terms of reflectance and absorption loss and investigated their polarization dependence experimentally and theoretically in the spectral range from VUV to visible. The study for a silicon photodiode reveals that its reflectance and polarization dependence change significantly in the wavelength range approximately from 120 to 300 nm depending on its oxide thickness due to interference effects. The experimental results for silicon photodiodes on the responsivity and its polarization dependence are explained very well by an optical model. This good agreement confirms that there is no dead layer except for an oxide layer in certain photodiodes[1]. By overcoating a layer or some layers to be investigated directly onto the surface of such silicon photodiode, we can obtain the transmittance of the film. Since detector responsivity polarization dependence is predictable, this technique will be useful for film characterization by ellipsometric techniques using both reflectance and transmittance.

[1] L. R. Canfield, Jonathan Kerner, and Raj Korde, Appl. Opt. 28, 3940 (1989).