Comparison of NIR to MIR Optical Constants of Polymers for Packaging by Spectroscopic Ellipsometry

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The main substrate-polymer material interfaces that can be found in a power mechatronic modules are due to the presence of silicon chips, copper (busbar and wires) and aluminum from the cooling element [1]. In this work spectroscopic ellipsometry in the NIR to MIR is used to characterize samples prepared by spin coating technique to study the effect of different substrates on the optical properties of several polymers [2, 3]. Samples are in solid form or deposited as films on quartz substrates, silicon, aluminum or nickel-plated copper. A rotating compensator ellipsometer (IR-VASE) from JA Woollam is used to study the polymer-substrate interfaces from 1.7 microns to 30 microns (333 cm^{-1} to 5900 cm^{-1}). The measurements are performed at an angle of incidence of 70 °. The refractive index n and the extinction coefficient k of the samples are determined at ambient temperature for 7 different polymers (B1, B2, B3, B4 for the bi-component, M1, M2, M3 for the mono-component and E1 for the epoxy resin). The experimental data are analyzed with the "General Oscillator (Osc-Gen)" optical model using the software provided with the ellipsometer. For thin films, the structural model is comprised of a substrate (QZ, Si, Al, Cu-Ni) having a thickness of 1 mm covered with a layer of polymer. The values of thicknesses determined by ellipsometric study in the UV-Vis [1, 2] are used as starting values in the structural model to begin the fit.

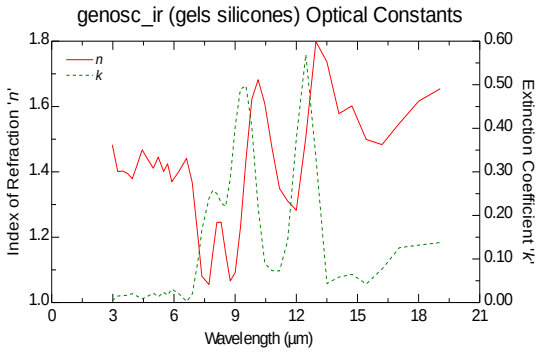

Fig. 1 Real part n and imaginary part k of the complex refractive index of polymer B1

n is a decreasing function with the wavelength λ but the presence of absorption zones ($k \neq 0$) modifies this decay law and regions of anomalous dispersion (n increases with λ) are also present. n values are below 1.8 from 1.7 µm to 18 µm and increases with λ beyond 18 µm probably due to an absorption. The number of peaks observed is between 6 and 8 for the silicone gels and 12 E1. When comparing the results obtained with spectroscopic ellipsometry and "Attenuated Total Reflection" (ATR) technique, a good agreement on the position of the lines and absorption bands are found. Moreover, the silicon substrate and the metals alter differently the optical properties of the polymers studied.

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References

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