

Thermal Characterization of Multi-layer Films by IR Thermography

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The methodology and experimental technique used to quantify and determine the thermal characterization of interfaces are important with regards to thermal science and technology. In this study, the thermal diffusivity of a cross section of polymer film layers, including the interfaces, was performed by an edge view observation of IR thermography and a Fourier transformed phase image.

An InSb FPA that is sensitive in the spectral band 3 to 5 μm with an array of 256x256 pixels allowed a 1.9x1.9 mm² specimen area giving a spatial resolution of 3 ~ 7.5 $\mu\text{m}/\text{pixel}$, by using an optical system comprised of a SiGe micro lens [1, 2]. The time resolved IR photograph of the temperature wave propagating on the cross section of the specimen with and without heat conductive grease compounds at the interfaces was obtained at a frame rate of 60 ~ 5000 Hz, corresponding to the pixel size 256x256 ~ 64x64. The frequency of the temperature wave generated by a.c. Joule heating was in the range of 0.01 to 10 Hz.

The phase image was compared and fitted by appropriate numerical simulations of the thermal field in multi-layered films. Since the geometry of the interfaces and the heater have plane symmetry (1D geometry), the theoretical approach analyses the thermal field in each layer as a superposition of forward and backward plane thermal waves in the direction out of the plane [3]. The phase and amplitude jumps observed experimentally indicate the presence of a thermal boundary resistance between each layer. This effect has been modeled by introducing thin surface skins of poor conductors (air, grease) among the polymeric layers. The numerical analysis allows for the estimation of the thicknesses of these skin layers of less than 3 μm .

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