Photothermal Radiometry Measurement of Thermal Diffusion in the Transmission Configuration and 3-D Effects

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Photothermal radiometry is a technique that has shown to be useful and highly reliable in the non-invasive and non-destructive evaluation of thermal properties of materials. In this work a theoretical and experimental analysis taking into account the finite size of the laser beam spot and its effect when measuring the photothermal radiometry signal in the transmission configuration is presented. The study is performed considering modulation frequency scans and a tree dimensional heat diffusion model induced by a laser beam with a Gaussian spot. It is shown that the 3-D effects are clearly appreciated in the thermally thin regime. In contrast, it is shown that the phase in the thermally thick regime is not as sensitive to 3-D effects, however they are important when the ratio R/L<5, where R is the laser spot effective radius and L is the sample thickness. Experimental results for materials of different thermal diffusivity are shown using different R/L ratios. It is shown that using the complete expression of the predicted temperature, the experimental data can be fitted even in a wide range of frequency, from thermally thin to thermally thick regimes. The methodology is applied to the study of microstructured materials formed by microparticles of carbonyl iron in a polyester matrix.