DEVELOPMENT OF MODELS FOR THE STUDY OF HEAT TRANSPORT IN ULTRA-THIN LAYERS BY TRANSIENT GRATING SPECTROSCOPY

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In this work, the development of models to analyse the dynamical heat transport properties (thermal diffusivity and thermal effusivity) in opaque solid materials, using Transient Grating Spectroscopy, is presented. In Transient Grating Spectroscopy (TG), short laser pulses impinging on a sample, create a diffraction pattern on the surface. By analysing, the temporal decay of the temperature in the grating allows to analyse heat transport of the material. In this work, heat transport equation for multilayered systems were solved using appropriate boundary conditions and using the Fourier and Laplace transforms. As a result of complexity of the obtained solutions in Laplace space, the analysis of the temperature in time space was performed applying numerical algorithms to calculate the inverse Laplace transform of the solutions.

Using this method, simulations of the thermal profiles in solid semi-infinite, finite and two- and three-layer systems, were performed. The special case of glass, molybdenum, stainless steel, polyester-resin were considered. Previous studies have shown how thermal decays are sensitive to the grating period size for semi-infinite opaque materials. The research presented here allowed us to analyse which thermal properties could be measured, using a specific configuration for thermal contrast, time scale, thermal properties of the layers, as well as grating period for multi-layered systems. The sensitivity analysis, based on grating period, proved that if the analysed sample has large thermal conductivity and thermal diffusivity, the thermal profile is highly sensitive to the grating period. On the other hand, results show how thickness of the illuminated layer and the kind of substrate affect the thermal decay signal giving us an idea of how the transient grating experiments should be performed to be able to reliably measure the thermal properties for ultrathin layer deposited on different kinds of substrates.

Keywords: Transient grating spectroscopy, thermal diffusivity, thermal effusivity

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