THERMAL CHARACTERIZATION OF POLYMERIC THIN FILMS USING PHOTOACOUSTIC SPECTROSCOPY

Mareny Guadalupe Fernández Olaya[1], Miguel A. Ruiz Gómez[2], David Meneses-Rodríguez[2], Pablo Martínez Torres[3], Juan José Alvarado Gil[1]

[1]CINVESTAV-IPN Merida, Applied Physic, Mexico. [2]CONACYT-CINVESTAV del IPN, Applied Physic, Mexico. [3]Universidad Michoacana de San Nicolás de Hidalgo, Physics Institute, Mexico.

The formation of films solution evaporation is a common process in daily life and industry. In technological applications, it is important to control the drying process and determine the thermal properties of materials, which can vary considerably in composition and microstructure during their production. The determination of the thermal properties has become an important and well-established application of Photothermal Techniques, that are based on the generation of thermal waves through a material using a modulated light source. In this work, the theoretical study of the temperature of the system by Photoacoustic (PA) Spectroscopy was performed, solving the heat diffusion equation for modulated flux, and considering a flat two-layer system, surrounded by air, in which the upper layer decreases in time. The graph shows three well defined stages. In the first one, the signal remains nearly constant. The second one is characterized by a minimum, related to thermal-wave interference, and in the last stage, the amplitude was going to a high stable signal corresponding to the end of the film formation process. The PA signal is in dependence of the evaporation rate, the final thickness and characteristic time for the film formation. A simple approximation of the normalized thermal wave allows us to determine the volumetric heat capacity. For a complete thermal characterization, the two-layer system is solved considering a temperature discontinuity between both layers, as a thermal resistance that is related to the thermal conductivity. It is possible to study a multilayered system of thin films using our methodology, the influence of thermal properties is analyzed for a three-layers system.

Keywords: Photothermal Spectroscopy, Thermal Wave, Evaporation Rate

Acknowledgment:

The work was financially supported by CINVESTAV-Unidad Mérida, and projects SRE-AMEXCID-2016-1-278320, CB-2015-255109 and Cinvestav Scientific Research and Technological Development Fund No. 98.

Presenting author's email: marfer.005@gmail.com