Modeling of the Transient Thermal Response in Solids for Application to IR-PTR

J. Hernández Wong[1], J. B. Rojas[2], J. A. Calderon Arenas[2], E. Marin Moares[2], V. Suarez Quezada[3], L. Olivo Arias[2]

[1] Catedrás CONACyT-Instituto Politécnico Nacional, Centro de Investigación en Ciencia Aplicada y Tecnología Avanzada, Mexico City, Mexico
[2]Instituto Politécnico Nacional, Centro de Investigación en Ciencia Aplicada y Tecnología Avanzada, Mexico City, Mexico
[3]Catedrás CONACyT-Universidad Autónoma Metropolitana, Iztapalapa, Mexico

Abstract

In this work, theoretical and numerical models solved by COMSOL Multiphysics® for the heat diffusion in homogenous solids, suitable to be used in the infrared photothermal radiometry technique, are presented. The theoretical calculations and the numerical simulations were obtained by solving the 3D heat diffusion equation considering a monochromatic Gaussian excitation beam and finite samples, without any assumption about the thermal regime; In the numerical simulation, the Heat Transfer module was employed with the heat transfer in solids interface in a transient study. The time stepping parameter was used in the strict mode to improve the resolution of the temperature field. However, while the theoretical model considers a linear temperature dependence of the heat losses due to thermal radiation (to preserve linearity in the model), the numerical model considers the full expression of the Stefan-Boltzmann law. Both, the theoretical and the numerical models, were applied to materials characterized by: (a) high emissivity and low thermal conductivity values, and, (b) low emissivity and high thermal conductivity values.
The data obtained by COMSOL Multiphysics®, validate the theoretical model and reduce some limitations of the experimental setup, especially with materials with high thermal conductivity.

Figures used in the abstract

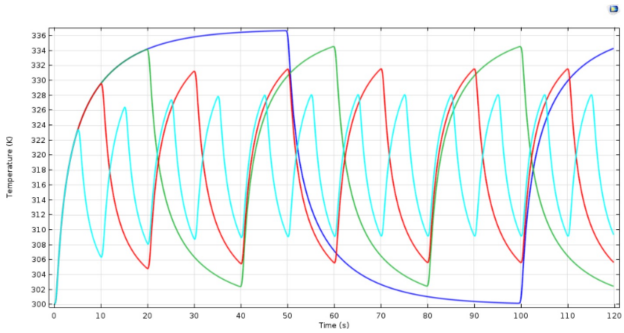

Figure 1: Temperature gradient at different frequencies.