Application of COMSOL Multiphysics in the Study of Heat Transfer in Solids: Comparison with Measurements Obtained By Means of Infrared Photothermal Radiometry

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Abstract

We report the use of the Heat transfer Module of COMSOL Multiphysics and a technique based on Infrared Photothermal Radiometry to study the heat transfer of a homogeneous and isotropic solid material excited by a periodic laser beam on the front side of the sample and an infrared detector on the rear side in order to obtain the evolution of the temperature difference with the time exposure. We used COMSOL Multiphysics software to obtain the temperature distribution in the sample as a function of time by means of the solution of the heat diffusion equation (Figure 1) with the next boundary conditions shown in Figure 2. Here, $w=2\pi f$ is the angular frequency, f is the modulation frequency of the incident radiation, W is the power laser and L is the thickness of the sample in form of plate. Finally, we compared the experimental with the simulated results obtaining a good agreement. Moreover, by means of fitting the mathematical model with the experimental results we can obtain the thermal conductivity and thermal diffusivity of the sample. These results show the utility of the technique in the thermal characterization in solids.

Reference

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Figures used in the abstract

$$-\frac{\partial}{\partial x}\left(k\frac{\partial T}{\partial x}\right)+\dot{q}=\rho c\frac{\partial T}{\partial \tau}$$

Figure 1

$$\Delta T\big|_{x=0}=W\left[0.5+((2/\pi)*(\sin(w*t))+((1/3)*(\sin(3*w*t)))\right]$$

$$-k_s\,\Delta T\big|_{x=L}=-k_a\Delta T\big|_{x=L}$$

Figure 2

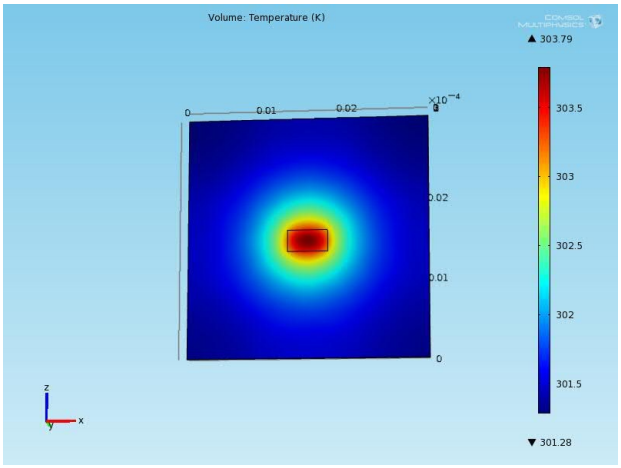

Figure 3