Analysis of the Absorption Phenomena through the Use of Finite Element Method

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INTRODUCTION: Copper alloys are materials known for a wide range of applications. Currently more than 400 copper alloys are known, among which brass and bronze are distinguished. Photothermal Radiometry Technique is usually used to characterize these materials subjected to a laser heating, producing a thermal wave that is captured with a detector by means of the amplitude and phase parameters. A numerical model using the finite element method (FEM) is developed to describe absorption phenomena using the Beer-Lambert law.

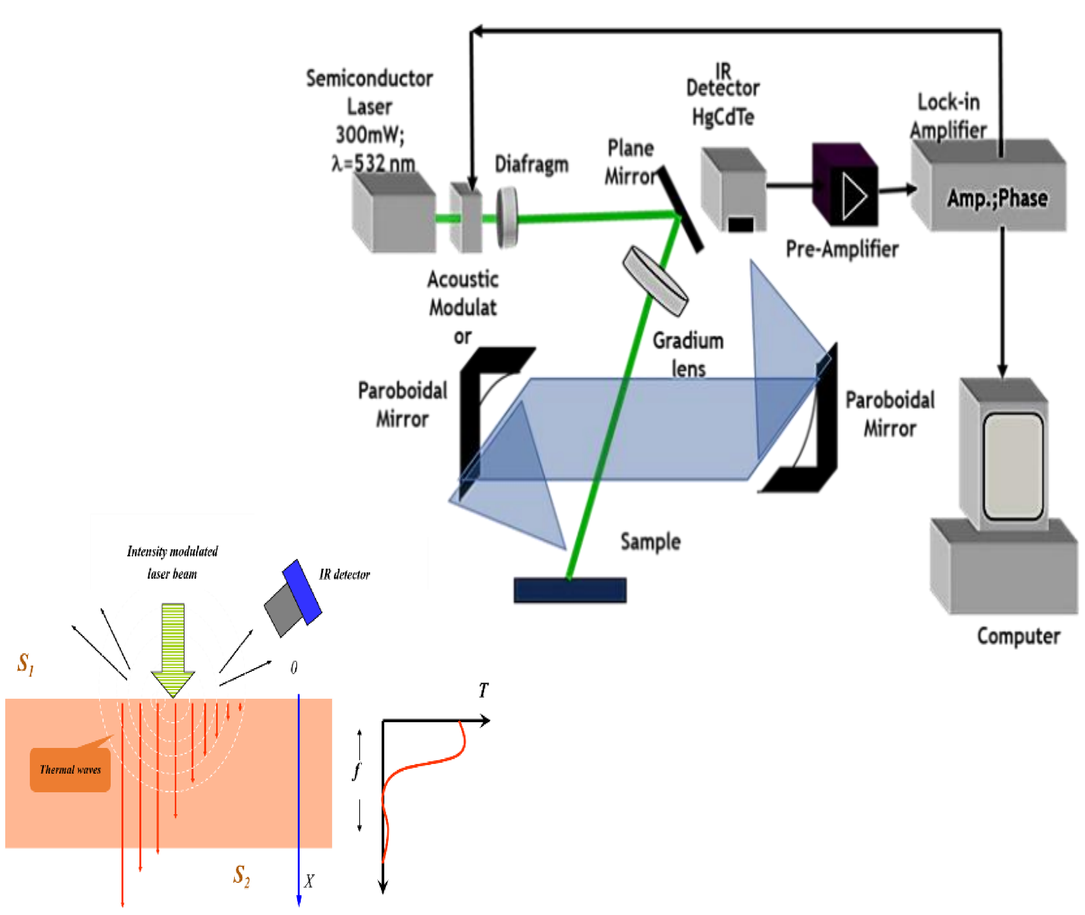

Figure 1. Photothermal Radiometry Technique for characterization of a material.

COMPUTATIONAL METHODS: The Heat Transfer Module was used to developed a simple model for the analysis of laser light absorption in alpha brass samples. Beer Lambert law is resolved in the internal domain of a cylinder. The equation itself is implemented via the General Form PDE interface.

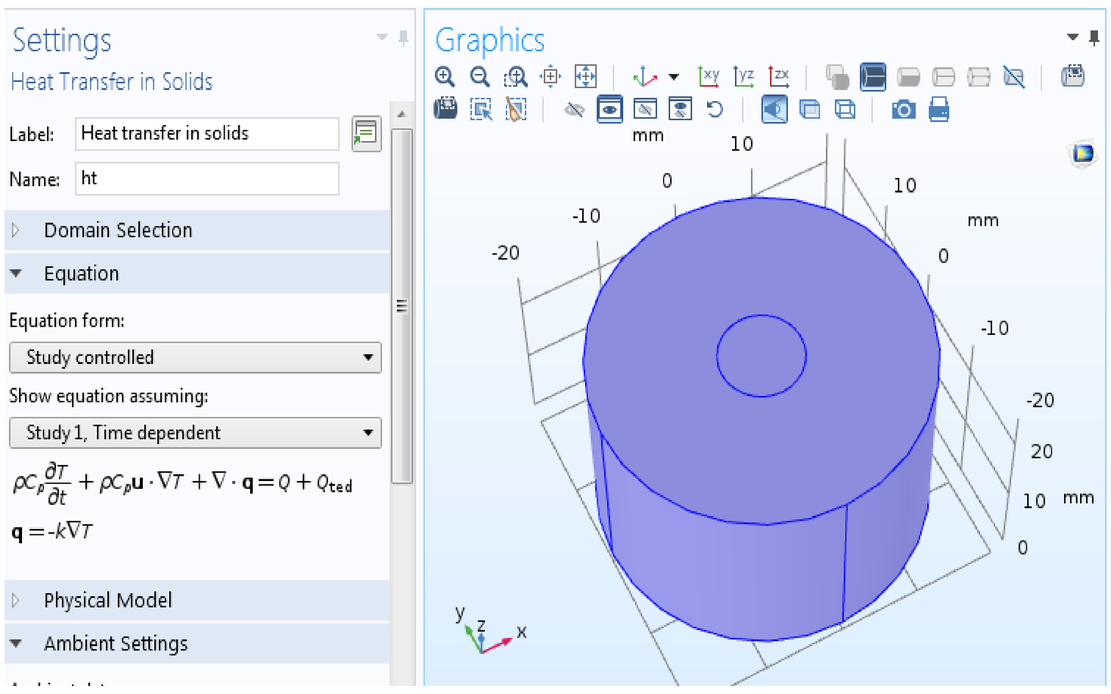

Figure 2. Definition of the cylindrical geometry, parameters and initial conditions for the absorption analysis model in alpha brass.

RESULTS:

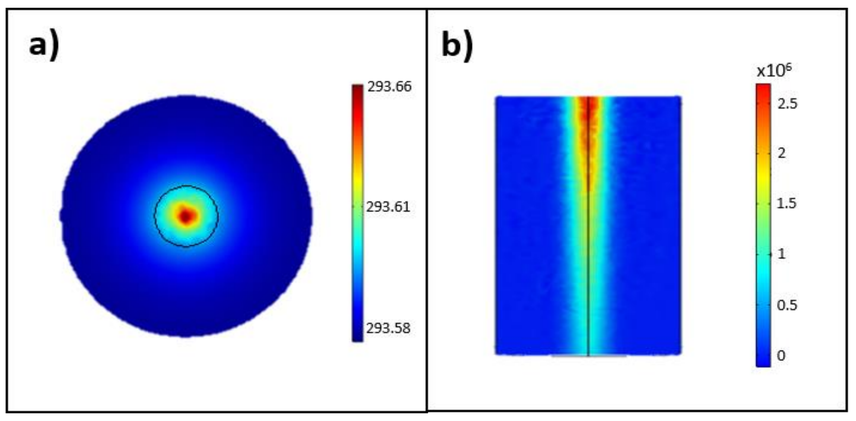

Figure 3. Propagation of heat in the alpha brass material a) Surface profile and b) penetration profile.

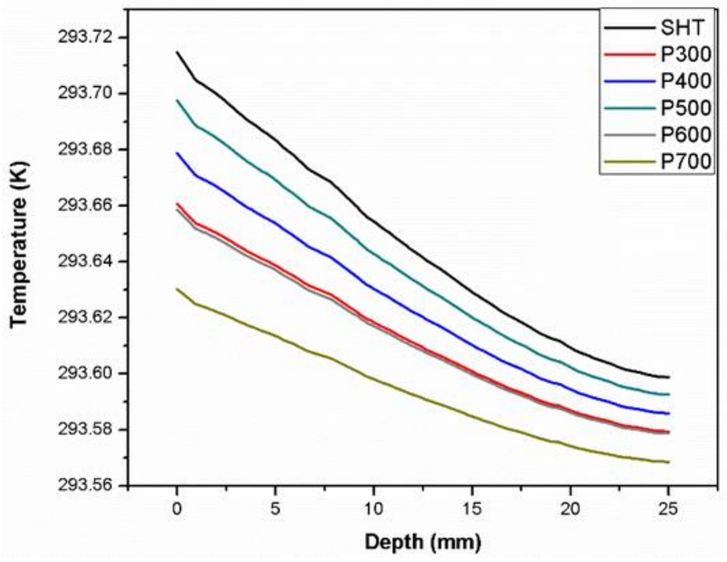

Figure 4. Temperature as a function of depth along the centerline over 40 seconds of time, for six different samples of alpha brass.

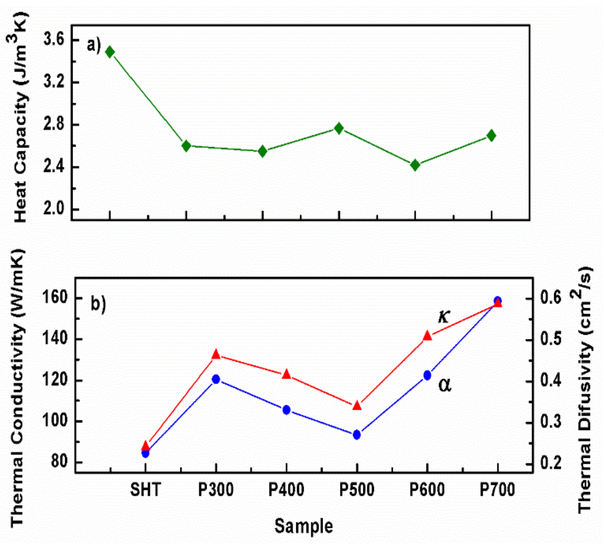

Figure 5. Thermal properties of Kunial brass samples studied a) heat capacity, b) diffusivity (**κ**) and conductivity **(α)**.

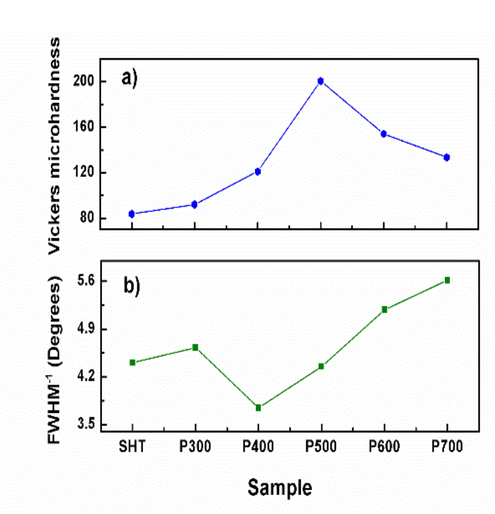

Figure 6. a) Vickers microhardness and b) $FWHM^{-1}$ of brass samples with different thermal properties.

CONCLUSIONS: The model developed on the COMSOL Multiphysics platform is a basic approach to the application of the law of Lambert beer applied to the absorption phenomena of laser light in a material. The theoretical results obtained describe temperature variations as a function of the penetration depth of the incident radiation in the material, which in turn depends on factors such as the incident power.

REFERENCES:

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2. Rojas-Rodriguez, I., *et al*., The influence of the precipitation heat treatment temperature on the metallurgical, microstructure, thermal properties and microhardness of an alpha brass, Mat. Sciences and Applications, 9, 440-454 (2018).