

# Optimization of Thermal Properties Identification of Complex Thin Films Using MATLAB® and COMSOL Multiphysics

Nadjib Semmar<sup>1</sup>, Birane Wane<sup>1</sup>

<sup>1</sup>GREMI, UMR7344, CNRS-University of Orleans, Orléans Cedex 2, France

## Abstract

**Introduction:** The importance of laser processing and thermal properties investigation of bulk materials and thin layers is still increasing. For thermal properties investigation many experimental systems were developed based on the photothermal effect [1]. One of typical ways is to induce a rapid surface temperature increase is to use a pulsed laser beam, create a simplified model of this interaction, and compare the obtained results with experimental ones.

A 2D transient heat conduction model was created in COMSOL Multiphysics in order to simulate the temperature change in a multilayer material irradiated by a KrF laser pulse (rapid photothermal process). From the temperature field and specifically from surface temperature thermophysical properties [2] of the material can be deduced. MATLAB® is used to input the experimental data in a primary loop linked with COMSOL. A least square method is generated in MATLAB® to run the COMSOL loop in order to optimize the identification method. Notice that in the present case, a real time laser beam distribution is considered in the COMSOL model. Linking COMSOL and MATLAB: The main purpose is to build up a loop between MATLAB® and COMSOL using experimental data in order to optimize the COMSOL multilayer model results and then to determine material thermal properties. COMSOL's LiveLink for MATLAB® is used to connect the COMSOL model with the MATLAB® routine that uses the least square method (Figure 1).

**Results:** For the thermal model the Heat Transfer in Solids physics interface and a Time Dependent study have been chosen in COMSOL in order to solve the heat conduction equation. Several analyses were conducted on Ti/AlN/Si structures that have major applications in transmission and microelectronic fields. Data relevant to the thermal conductivity of AlN thin films (200 to 8000 nm thickness) were returned and ranging from 50 to 200 W/(m\*K). These values were determined as a first step by using a triangular shape of the laser beam time distribution. We suggest to study these samples using this new MATLAB®-COMSOL loop. Finally because AlN thin films are a semi-transparent medium, COMSOL's Heat Transfer Module has been also used to evaluate the heat conduction due to photons in order to correctly evaluate the effective thermal conductivity.

## Reference

- [1] J. Martan, N. Semmar, O. Cibulka, 'Precise nanosecond time resolved infrared radiometry measurements of laser induced silicon phase change and melting front propagation', Journal of Applied Physics (2008).
- [2] Balageas, 'Pulsed photothermal modeling of layered materials', Journal of Applied Physics (1986).

## Figures used in the abstract

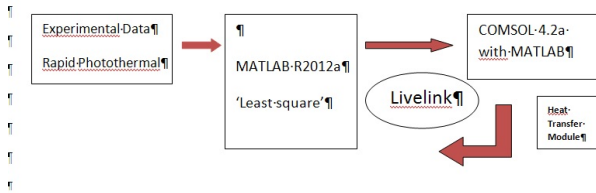


Figure 1