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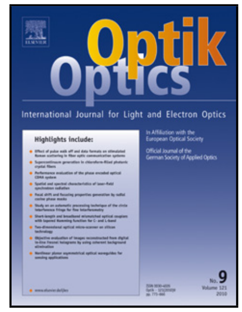

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Dynamic thermal response of aluminum films induced by femtosecond-pulsed lasers with temperature dependent optical properties

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ABSTRACT: This paper reports two optical models of temperature dependent reflectivity, *R*, and absorption coefficient, *α*, during femtosecond laser interaction with aluminum. After a comparison with existing experimental data, the critical point model (CPM) was incorporated into a two-temperature model (TTM) to simulate laser energy deposition and thermal response in an aluminum film irradiated by femtosecond laser pulses. The dynamic change of optical properties *R* and *α*, distribution of laser heat density, electron and lattice temperature of an aluminum film were investigated. Compared with constant reflectivities and absorption coefficients, dynamic reflectivities and absorption coefficients are recommended to be employed in modeling ultrafast laser heating.

Keywords: Femtosecond laser, Reflectivity, Absorption coefficient, Two-temperature model, Laser ablation

I. Introduction

Femtosecond laser material processing is a very effective means for micro/nano machining and surface modification of solid materials [1]. A number of theoretical investigations on ultrashort pulsed laser interactions with matter have been reported. Most of them are focused on fundamental thermal transport using a two-temperature model (TTM) [2-6]. Temperature-dependent thermophysical properties have been employed in simulating ultrafast laser heating. However, the optical parameters usually are treated as constants. In this paper, temperature dependent reflectivity, *R*, and absorption coefficient, *α*, are investigated to study their impacts on ultrafast thermal responses in an aluminum film.

To calculate temperature-dependent *R* and *α*, Neal et al. proposed a model with two Drude terms and used in the finite-difference time-domain (FDTD) method [7]. Vial et al. proposed a critical point model