

Accepted Manuscript

Title: Three-dimensional thermal simulation of nanosecond laser ablation for semitransparent material

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PII: S0169-4332(13)01148-3
DOI: <http://dx.doi.org/doi:10.1016/j.apsusc.2013.06.048>
Reference: APSUSC 25852

To appear in: *APSUSC*

Received date: 12-4-2013
Accepted date: 9-6-2013



Please cite this article as: J. Ahn, S.-J. Na, Three-dimensional thermal simulation of nanosecond laser ablation for semitransparent material, *Applied Surface Science* (2013), <http://dx.doi.org/10.1016/j.apsusc.2013.06.048>

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Three-dimensional thermal simulation of nanosecond laser ablation for semitransparent material

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Abstract

A numerical study of nanosecond laser ablation process for semitransparent material was performed. A heat source model using ray tracing is suggested for three-dimensional simulations of laser material processing based on the volume-of-fluid (VOF) method. The model is capable to describe both the ray transmission into the material and the reflections from the material surface. In the computational implementation of the model, a stochastic approach was introduced to avoid the recursive branching of an incident ray into transmitted and reflected rays. Since the ray tracing highly depends on the shape of the target material, proper surface reconstruction method is also considered. For the spatially continuous representation of the free surface of the material, the piecewise linear surface of the VOF method was converted into the level set surface reconstructed by the interpolation of the signed distance function. The applicability of the model was validated by example simulations and experiments on polyimide workpiece with nanosecond laser.

Keywords : laser, ablation, reflection, transmission, volume of fluid, ray tracing

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