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# Journal of Applied Mechanics

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J. Appl. Mech. / Volume 68 / Issue 3 / TECHNICAL PAPERS

## Boundary Element Formulation for Thermal Stresses During Pulsed Laser Heating

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ABSTRACT | REFERENCES (40) | CITING ARTICLES

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Pulsed lasers are used in a variety of materials processing applications that range from heating for metallurgical transformation to scribing vehicle identification numbers on anodized aluminum strips. These lasers are commonly configured to deliver a large quantity of heat energy in very short time intervals and over very small areas due to the manner in which radiant energy is stored within, and then released from, the laser resonator. At the present time, little is known about the effect of pulse duration on thermomechanical distortion during heating without phase change. To explore this issue, a boundary element method was developed to calculate temperature, displacement, and thermal stress fields in a layer that is rigidly bonded to an inert semi-space. The layer absorbs thermal energy from a repetitively pulsed laser in the plane of its free surface. The effects of two pulse durations, which differ by four-orders-of-magnitude, were examined in this work. The temporal profiles of ultrafast pulses of the order of ten picoseconds (such as those emitted by a mode-locked laser), and pulses of the order of tens-of-nanoseconds (such as those emitted by a Q-switched Nd:YAG laser) were mathematically modeled using a rectified sine function. The spatial profile of each pulse was shaped to approximate a Gaussian strip source. The equations of coupled thermoelasticity, wherein the speed of mechanical distortion due to material expansion during heat absorption is finite, but the speed of heat propagation within the layer is infinite, were solved for both pulse durations. The resulting temperature and stress fields were compared with those predicted in the limit of no thermomechanical coupling.



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