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Vikash Kumar, Uday S. Dixit, Jian Zhang

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Determination of thermal conductivity, absorptivity and heat transfer coefficient during Laser-based manufacturing

Vikash Kumar[a], Uday S. Dixit[a*] and Jian Zhang[b]

[a]Department of Mechanical Engineering, Indian Institute of Technology Guwahati, Guwahati 781039, Assam, India

[b]Shantou Institute for Light Industrial Equipment Research, Shantou University, Shantou, 515063, China

Abstract

An inverse method is proposed to estimate the thermal conductivity, absorptivity and heat transfer coefficient for a laser irradiated sheet based on the measurement of temperature. The inverse model makes use of the temperature-history computed by a finite element method based direct model that takes the average thermal properties of the sheet as input. The thermal conductivity, absorptivity and heat transfer coefficient are estimated by minimizing the difference between actual and model-predicted temperatures of the laser irradiated sheet. The efficacy of the proposed inverse technique is demonstrated with the help of two examples. The maximum deviation of inverse prediction from the actual values is 0.03 for the absorptivity and 2 $W/m^2.°C$ for the heat transfer coefficient. Average value of the thermal conductivity lied in the range of values of temperature-dependent thermal conductivity for the temperatures encountered by the irradiated sheet. Simulations showed a good agreement between the temperatures predicted from the actual and inversely estimated parameters.

Keywords: Inverse technique; finite element method; thermal conductivity; absorptivity; heat transfer; temperature-history.