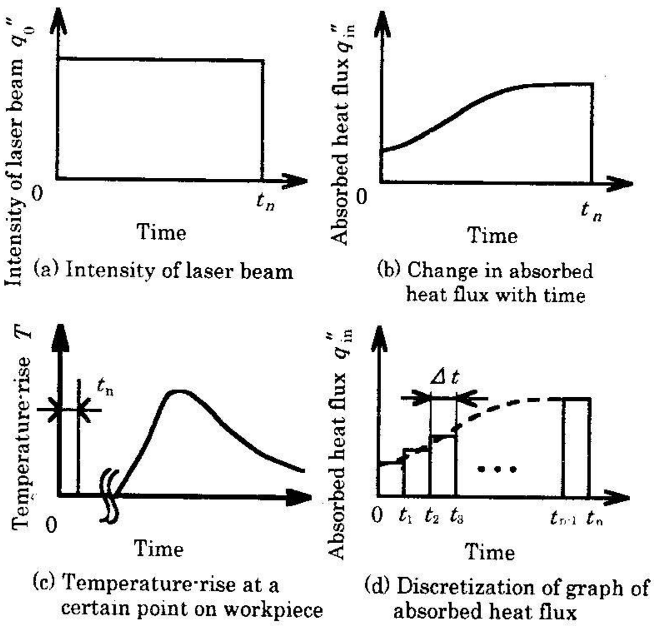
Influence of Physical Properties of Workpiece Material on Laser Piercing Difficulty

Shohei Matsuyama, Masanori Kunieda and Toshitaka Satsuta

J. of JSPE, 66, 5, 699-703 (2000)

This paper describes the influence of physical properties of workpiece material on the difficulty in laser piercing through measurement of the absorption factor change with extension of the depth of hole pierced by a YAG laser. To measure the absorption factor, which is defined as the ratio of the power absorbed by the workpiece to the incident laser power, the inverse problem solution was utilized. The changes in the absorption factor obtained for both copper and steel workpiece show a similar increase with increasing the depth of the processed hole, and the absorption factor takes the maximum value just before the penetration followed by a rapid decrease after the penetration. The maximum value is about 90% when copper is used, and 100% when steel is used as a workpiece material. This fact indicates that the absorption factor in laser piercing does not depend on the intrinsic reflectivity of the material. When the workpiece is thick, the absorption factor increases with the increase of the depth of the keyhole, and after reaching about 100%, the increase is stagnated and the absorption factor is saturated at 100% so far as the penetration does not occur. From the above results, it is concluded that the absorption factor in laser piercing is determined not by the intrinsic reflectivity of workpiece material but by the depth of the hole being processed. Consequently, difficulty in cutting copper workpiece by laser beam results from the high thermal conductivity of copper rather than its reflectivity.

Keywords: laser piercing, absorption factor, inverse problem, transient heat conduction, finite-difference method, reflectivity, thermal conductivity



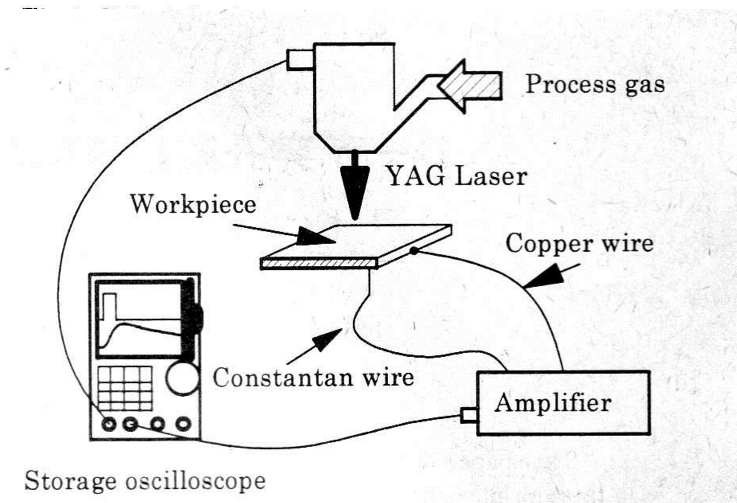


Fig.2 Experimental setup for temperature measurement

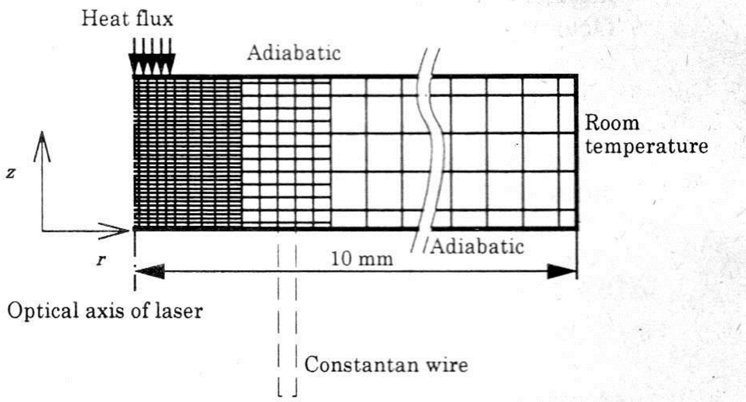


Fig.3 Model for computation of workpiece temperature

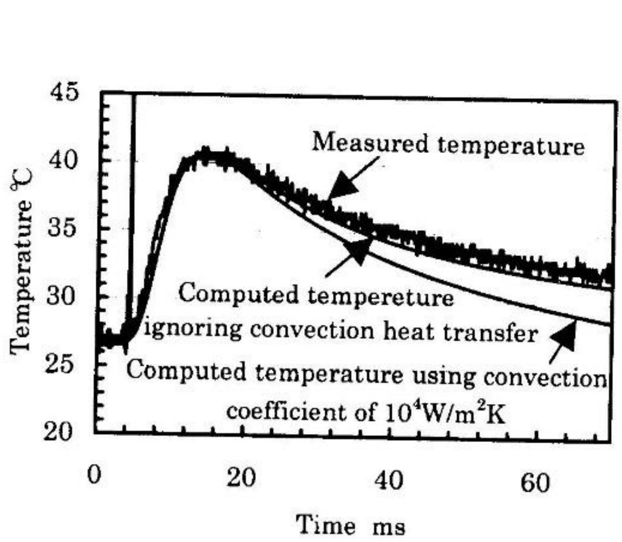


Fig.4 Comparison of computed temperature changes with measured one

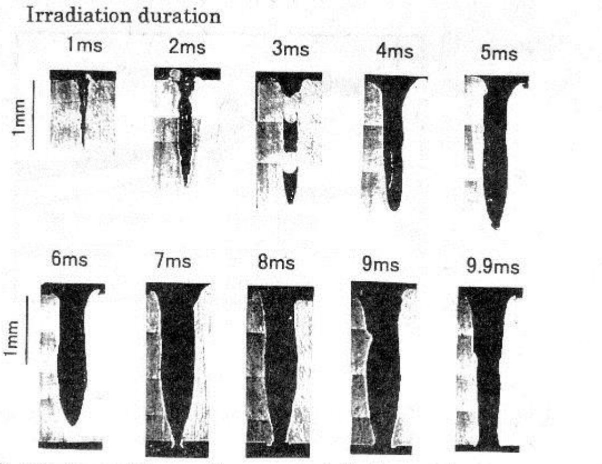


Fig.6 Cross sections of processed holes with increase of irradiation duration when copper is used as workpiece material

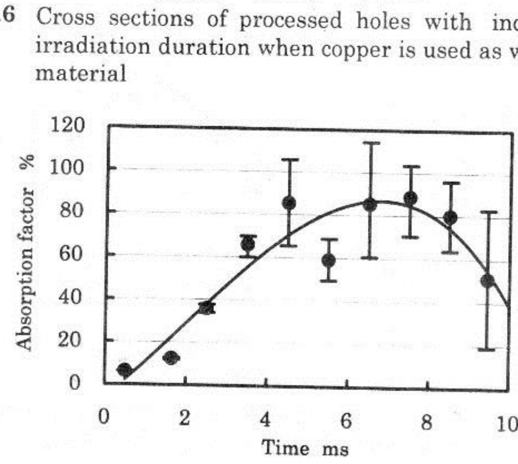


Fig.7 Change in absorption factor when copper is used as workpiece material

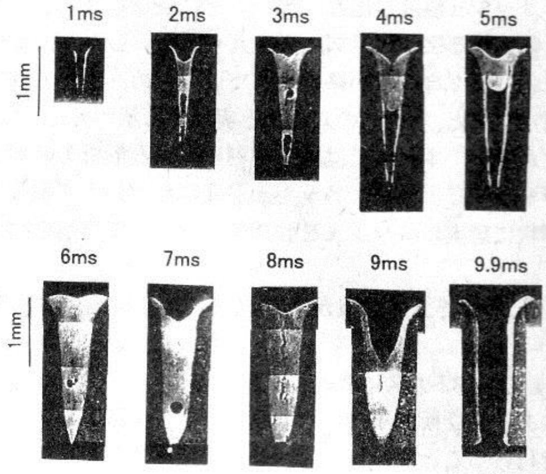


Fig.8 Cross sections of processed holes with increase of irradiation duration when steel is used as workpiece material

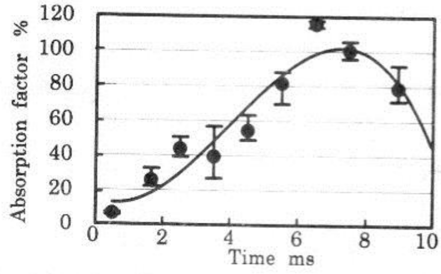


Fig.9 Change in absorption factor when steel is used as workpiece material