# A First Approximation To The Modeling Of Vapor Plume Evolution In Laser Welding

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## Abstract

A quantification of spatial and temporal evolution of laser-induced plume would enhance the comprehension of high speed imaging results and allow optimizing the acquisition conditions for the emission spectroscopy. What temperature and concentrations of the evaporating species are sufficient for obtaining an emission spectrum? What part of the plume should be targeted? How long does the plume persist after the extinction of the laser? To answer these questions, a first aproximation to the multiphysical modeling of the vapor plume during a millisecond scale Yb:YAG laser pulse on the metallic material was attempted. A time-dependent 2D axisymmetric model comprising strongly coupled heat transfer, fluid flow, diffusion and moving mesh problems is proposed. In the metal domain, the heat transfer involving the evaporative energy loss is coupled with a non-isothermal flow represented by incompressible Navier-Stokes equation that takes into account recoil pressure, surface tension, Marangoni effect and gravity. In the gas domain, the non-isothermal flow represented by compressible Navier-Stokes equation is strongly coupled with diffusion equation based on the flux of evaporating metal atoms and Fuller approximation of diffusion coefficient. The proposed model was applied to the case of aluminum and compared with experimental results of high speed imaging and post-mortem analysis of the impact zone.

## Figures used in the abstract

**Figure 1** : The molar % of Al atoms diffused above laser-induced impact in A5754 alloy.