MASTER INTERNSHIP M2 PPN (5 months)

2023-2024

Title of the project: Emission spectroscopy and spectral imaging of laser interaction with copper/steel dissimilar joint

Supervisor(s): JOUVARD Jean-Marie , TOMASHCHUK Iryna

Laboratory / Department / Team : ICB/ PMDM/ LTm

Summary:

The interaction of a high-power laser beam with metallic material results into formation of the vapor-filled cavity called the keyhole, while the vaporized matter forms an expanding vapor plume in the air. The behavior of the keyhole defines the quality of laser machining of the metallic materials (welding or cutting). If the laser beam irradiates the joint between two metals exhibiting a significant mismatch in their physical properties, simultaneous vaporization and convection phenomena result in the formation of the asymmetric keyhole, and complex movement of the molten material. The comprehension of keyhole behavior in this case is essential for the successful joining of the materials. The study of the vapor plume is also useful as it reflects the behavior of the keyhole.

Recently our research group developed the methodologies to study the keyhole and the vapor plume by high-resolution emission spectroscopy and high-speed imaging methods, on the example of dissimilar joint between aluminum and titanium. The aim of the present mastership is to apply these methods to another dissimilar couple – copper/stainless steel – to characterize plume and keyhole behaviors. The specificity of this couple consist in very important mismatch in laser absorptivity and thermal conductivity of the joined metals.

The internship contains the following tasks : 1) Spectroscopic characterization of the plume (determination of evaporated species and spectral line profile analysis with the aim of determining temperatures); 2) the in-situ observation of the keyhole and the plume using different UV-vis filters that allow obtaining the thermal imaging and to map the atomic emissions of copper and steel elements in the keyhole and in the plume; 3) spectroscopic characterization of the plume (determination of evaporated species and their temperature through Boltzmann plot method); 3) post-mortem characterization of the impact zone by SEM-EDS. The dissimilar joints will prepared with pulsed Yb:YAG laser in butt and overlap configurations; 4) comparison with numerical simulation models.

Our team is located on the Campuses of IUT Le Creusot or IUT Chalon-sur-Saône (1 hour by train from Dijon).

Contacts : jean-marie.jouvard@u-bourgogne.fr, iryna.tomashchuk@u-bourgogne.fr

Type of project (theory / experiment): experiment

Required skills: basic knowledge of atomic spectroscopy and image treatment will be an advantage