Planar laser-induced incandescence of iron particles in welding fume

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This paper presents the application of laser-induced incandescence to the measurement of metal and metal-oxide particles resulting from arc welding. Laser-induced incandescence measurements were combined with other optical techniques to investigate spatial distribution and density of particles produced from two arc welding processes. The experimental setup used is outlined along with the effect of different optical variables critical in developing applied optical measurements.

Introduction

Today there is an increased importance being placed on health and safety in the work place. This can be attributed to both the economic value and legislative necessity of maintaining healthy staff. Occupational hazards come in many forms, including electrical, physical, acoustical and chemical. In many occupations such as welding, workers are exposed to a combination of several hazards. One of these is the exposure to fine metal particles contained within the welding fume.

Traditional methods for studying these fumes involve welding within a confined space and collecting these particles in filter paper. While this method is important in determining a fume formation rate it however provides little information in the spatial distribution of the plume. Since the welders are in close proximity to the arc the distribution of the plume is an important factor in determining the welder exposure and inhalation of the fume.

The objective of this work was to apply laser-induced incandescence (LII) to study the spatial distribution and density of metal particles in the atmospheric generated by arc welding process. Two types of welding processes were studied, gas metal arc welding (GMAW) and flux cord arc welding (FCAW). The particle densities were varied by changing the welding conditions, namely the current and the voltage and the flow rate of shielding gas used in the welding process.

The LII signal intensity, as a function of laser fluence, was measured for the fundamental and second harmonic Nd:YAG laser wavelengths. The effect of using different optical colour filters on the LII signal was investigated. 2-d LII images of several gas flows were recorded. Furthermore, 2d images MIE scattering and LII images of the metal particles were collected simultaneously for selected welding conditions. In addition laser extension measurements were preformed aiming to obtain quantitative particles density. Typical LII image of metal particles generated in GMAW welding process is showing in Figure 1 below.

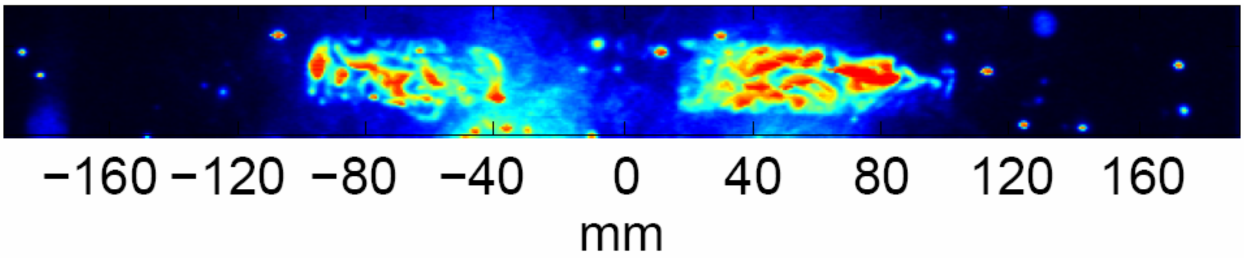

Fig. 1: LII image of GMAW plume cross-section 100 mm above arc.

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