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Analysis of metal vapour generation by laser ablation

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ANALYSIS OF METAL VAPOUR GENERATION BY LASER ABLATION

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CANDIDATE'S CERTIFICATE

I, Shervin Farjad, declare that this thesis, submitted in partial fulfilment of the requirements for the award of Master of Engineering - Research, in the Department of Mechanical, Materials and Mechatronic Engineering (MMM), University of Wollongong, is wholly my own work unless otherwise referenced or acknowledged. The document has not been submitted for qualifications at any other academic institution.

Shervin Farjad
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ABSTRACT

A chamber for ablation purpose was designed. This system was calibrated and the minimum spot size produced by the LASER on the sample surface and its relation with sample position adjustment experimentally, was determined. Applying this chamber, a technique for controlled generation of particulate by LASER ablation has been developed. The sampling was carried out in four different atmospheres; Air, CO2, Stainshield 66, and Argoshield 52. Furthermore, to survey and analyse the fume particle size range, *Scion Image* software was applied.

Scanning Electron Microscopy (SEM) and Transmission Electron Microscopy were chosen for analysis of fume particles morphology and size distribution. Energy Dispersive spectroscopy (EDS) and Scanning Transmission Electron Microscopy (STEM) were also chosen for chemical analysis.

The average fume particle size observed in all atmospheres was less than 0.1 micrometer. Considering the effect of oxidation potential of shielding gases, CO_2 generated the largest fume particles compared to Ar, while adding H_2 led to a smaller particles size.

The agglomeration pattern and morphology of fume particles was analysed as well. The survey of the agglomerated fume particles morphology with the SEM is more reliable since the TEM sample preparation could disturb the agglomeration pattern.

Fume particles agglomeration tended to grow three dimensionally while ferrous compound tended to make network and agglomerate together. The fume particles in the same size range tended to agglomerate in a 'chain' pattern which could grow up to 10 micrometers. The population of agglomerated particles with different sizes together varied between 3 and 400 particles. One of the most common patterns of these agglomerations is 'spherical' pattern.

While the fume particles can be in 'faceted' or 'spherical' shape, fume particles observed in this work were mainly 'faceted', independent of applied atmosphere.

The chemical composition of fume particles is variable of target (the sample) composition. In this work Fe, Mn, Si and O_2 were the elements observed in fume particles composition, while the elements found in the fume particles did not vary in different atmospheres.

It is also proposed that future works follow the investigation of the size distribution and morphology of fume particles while different welding electrodes are targeted by LASER and atmosphere is purged with shielding gases.

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