Project title:

Numerical modelling of turbulent transport in laser welding of dissimilar metal couple

Project description

Laser aided materials processing takes a key role in most of the modern methods of manufacturing. Laser welding is one of the most common laser aided materials processing operations. The mechanical strength and microstructure of the welded joint are strongly dependent on the thermal histories in the fusion zone and the nearby unmelted region during the processes. Molten metal flow is known to have a considerable effect on these thermal histories and solidification processes. Therefore, in order to predict the thermal behaviour of the process accurately, it is very important to have a thorough knowledge of the transport mechanisms inside the laser molten pool, which leads to a final resolidified microstructure. This knowledge can eventually be utilised to determine the process parameters such as welding power, laser beam-scanning speed in order to have a required quality of welded joint. In the present study the heat, momentum and species transport in laser molten pool will be studied in detail based on Computational Fluid Dynamics (CFD) simulations. Under most practical operating conditions the molten pool convection is turbulent in nature. However, the modelling of turbulent transport in molten metal pool in dissimilar metal welding is yet to be done. As the dissimilar metal welding is inherently three-dimensional (3D) in nature, 3D unsteady Detached Eddy Simulations (DES) simulations will be carried out for this project. In order to keep the study simple and in order to have fundamental physical insight a dissimilar couple based on copper (Cu) and Nickel (Ni) will be investigated as Cu and Ni are completely miscible in both liquid and solid phase but have very different physical properties. Based on fundamental understanding a systematic parametric study will be carried out in order to examine the effects of process parameters on key features of the molten pool namely, maximum temperature, pool penetration and pool aspect ratio (ratio of width to depth). The project outcome will be disseminated through journal articles and conference proceedings.

Given the fundamental nature of the work it is anticipated that the project outcome will be published in internationally reputed journals (e.g. Int. J. Heat and Mass Transfer, Numer. Heat Trans. etc.) and conference proceedings (e.g. Int. symp. on advances in comp. heat trans. etc.). The student will have ample opportunity to interact with the collaborators and the experts in this field of study. The candidate should have a good background of Mathematics, Fluid Mechanics and Thermodynamics. Some experience of computer programming will be preferred.

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