World Academy of Science, Engineering and Technology
International Journal of Mechanical and Materials Engineering
Vol:11, No:01, 2017

Experimental and Numerical Investigation of Micro-Welding Process and Applications in Digital Manufacturing

Authors : Khaled Al-Badani, Andrew Norbury, Essam Elmshawet, Glynn Rotwell, Ian Jenkinson , James Ren

Abstract : Micro welding procedures are widely used for joining materials, developing duplex components or functional surfaces, through various methods such as Micro Discharge Welding or Spot Welding process, which can be found in the engineering, aerospace, automotive, biochemical, biomedical and numerous other industries. The relationship between the material properties, structure and processing is very important to improve the structural integrity and the final performance of the welded joints. This includes controlling the shape and the size of the welding nugget, state of the heat affected zone, residual stress, etc. Nowadays, modern high volume productions require the welding of much versatile shapes/sizes and material systems that are suitable for various applications. Hence, an improved understanding of the micro welding process and the digital tools, which are based on computational numerical modelling linking key welding parameters, dimensional attributes and functional performance of the weldment, would directly benefit the industry in developing products that meet current and future market demands. This paper will introduce recent work on developing an integrated experimental and numerical modelling code for micro welding techniques. This includes similar and dissimilar materials for both ferrous and non-ferrous metals, at different scales. The paper will also produce a comparative study, concerning the differences between the micro discharge welding process and the spot welding technique, in regards to the size effect of the welding zone and the changes in the material structure. Numerical modelling method for the micro welding processes and its effects on the material properties, during melting and cooling progression at different scales, will also be presented. Finally, the applications of the integrated numerical modelling and the material development for the digital manufacturing of welding, is discussed with references to typical application cases such as sensors (thermocouples), energy (heat exchanger) and automotive structures (duplex steel structures).

Keywords : computer modelling, droplet formation, material distortion, materials forming, welding
Conference Title : ICAMMM 2017 : International Conference on Applied Mechanics, Materials, and Manufacturing
Conference Location : Jeddah, Saudi Arabia
Conference Dates : January 30-31, 2017