World Academy of Science, Engineering and Technology
International Journal of Materials and Metallurgical Engineering
Vol:11, No:12, 2017

Parameter Optimization and Thermal Simulation in Laser Joining of Coach Peel Panels of Dissimilar Materials

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Abstract : The quality of laser welded-brazed (LWB) joints were strongly dependent on the main process parameters, therefore the effect of laser power (3.2–4 kW), welding speed (60–80 mm/s) and wire feed rate (70–90 mm/s) on mechanical strength and surface roughness were investigated in this study. The comprehensive optimization process by means of response surface methodology (RSM) and desirability function was used for multi-criteria optimization. The experiments were planned based on Box– Behnken design implementing linear and quadratic polynomial equations for predicting the desired output properties. Finally, validation experiments were conducted on an optimized process condition which exhibited good agreement between the predicted and experimental results. AlSi3Mn1 was selected as the filler material for joining aluminum alloy 6022 and hot-dip galvanized steel in coach peel configuration. The high scanning speed could control the thickness of IMC as thin as 5 µm. The thermal simulations of joining process were conducted by the Finite Element Method (FEM), and results were validated through experimental data. The Fe/Al interfacial thermal history evidenced that the duration of critical temperature range (700–900 °C) in this high scanning speed process was less than 1 s. This short interaction time leads to the formation of reaction-control IMC layer instead of diffusion-control mechanisms.

Keywords : laser welding-brazing, finite element, response surface methodology (RSM), multi-response optimization, cross-beam laser
Conference Title : ICWMWMS 2017 : International Conference on Welding Metallurgy and Weld Metal Solidification
Conference Location : Miami, United States
Conference Dates : December 14-15, 2017