A Study on Continuous Beam Laser Welding of Dissimilar Materials Using Multiphysics Simulation

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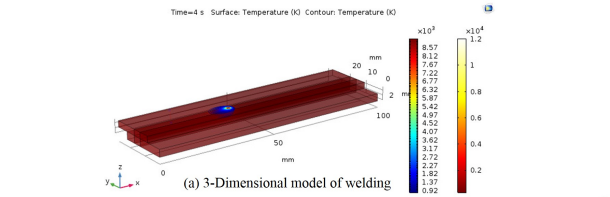
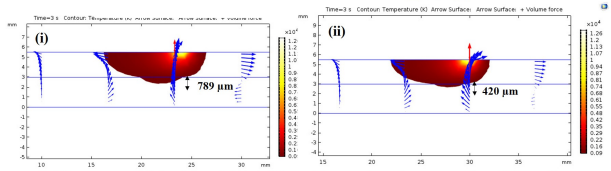
Abstract

Laser dissimilar welding finds their application mainly in the field of tailor-welded blanks (TWB). Tailor-welded blanks combining steel to aluminum alloys are widely used in automotive industry for achieving excellent lightweight structures and at the same time enhancing the functional performance of the vehicle. A three-dimensional axisymmetric model of heat transfer and fluid flow physics are developed to understand the complex physical phenomenon that governs the welding process. A top hat laser beam profile is used to study the effect of the power density of laser on the weld bead profile (weld depth and penetration depth). The model calculates the transient temperature profiles and the dimensions of the fusion zone. The effect of Marangoni convection on the weld width and weld depth penetration are also investigated in the model. The model calculations are compared with the experimental results of continuous laser welding.

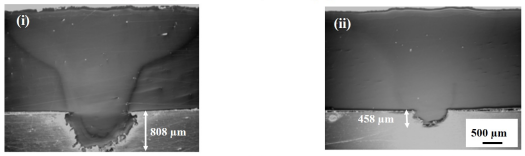
Figures used in the abstract



(a) 3-Dimensional model of welding



(b) Temperature distribution and shape of the weld zone along the cross-section of the weld under the influence of Marangoni convection at (i) laser power = 3.5 kW, scanning speed = 8 mm/s and (ii) laser power = 3.5 kW, scanning speed = 10 mm/s.



(c) Experimental results at (i) laser power = 3.5 kW, scanning speed = 8 mm/s and (ii) laser power = 3.5 kW, scanning speed = 10 mm/s.

Figure 1: A three dimensional model of dissimilar materials of steel and aluminium alloys was developed to study the influence of Marangoni convection on the shape and size of the weld pool. The transient temperature was studied using a 2D plot along a cut plane across the cross-section of the weld pool. The computational model was then compared with the experimental results.