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Modeling of transport phenomena in hybrid laser-MIG keyhole welding. (English)

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Summary: Mathematical models and associated numerical techniques have been developed to investigate the complicated transport phenomena in spot hybrid laser-MIG keyhole welding. A continuum formulation is used to handle solid phase, liquid phase, and the mushy zone during the melting and solidification processes. The volume of fluid (VOF) method is employed to handle free surfaces, and the enthalpy method is used for latent heat. Dynamics of weld pool fluid flow, energy transfer in keyhole plasma and weld pool, and interactions between droplets and weld pool are calculated as a function of time. The effect of droplet size on mixing and solidification is investigated. It is found that weld pool dynamics, cooling rate, and final weld bead geometry are strongly affected by the impingement process of the droplets in hybrid laser-MIG welding. Also, compositional homogeneity of the weld pool is determined by the competition between the rate of mixing and the rate of solidification.

MSC:

80A20	Heat and mass transfer, heat flow (MSC2010)
76T10	Liquid-gas two-phase flows, bubbly flows
76R50	Diffusion
76M12	Finite volume methods applied to problems in fluid mechanics
80A22	Stefan problems, phase changes, etc.
78A60	Lasers, masers, optical bistability, nonlinear optics

Keywords:

hybrid laser-MIG welding; keyhole; mixing; diffusion; mathematical model

Full Text: DOI

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