8th International Conference on Physical and Numerical Simulation of Materials Processing (ICPNS)

14–17 October 2016

Seattle, Washington | Hosted by Purdue University

SESSION 4: WELDING AND COATING, SALON E

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SUNDAY, OCTOBER 16, 2016

Computer-aided design of algorithms of pulsed control of arc welding process based on numerical simulation

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ABSTRACT

The results of physical and mathematical modeling allow to determine the influence of energetic parameters of the process on the condition of the “power source – electrode – arc – molten pool” electrodynamic system at each moment of time. There are a large number of investigations, which have been carried out to describe mathematically the “power source – welding arc” system in welding with systematic short-circuiting of the arc gap using the mean parameters of the conditions. However, they did not reflect the technological stability of the process, because a deviation of one of these parameters within the limits of a separate microcycle leads to its disruption. Extensive use is made of welding processes with algorithms of pulsed control on the basis of a strictly defined programme. In this case, the main energy characteristics of the welding arc are calculated in advance and are set in strict accordance with the varied technological parameters. These processes can be used efficiently only in the absence of perturbing influences on the object of automatic control. Physical and mathematical model describing processes of pulsed arc welding with systematic short-circuits of the arc gap in CO_2, original applied software have been developed in this paper. The results of numerical solution of the problem give the full information about object of control at each time moment; permit to determine the interrelation between energetic characteristics of the pulsed arc welding process ($I(t)$, $U(t)$), sizes of weld, and HAZ with the most important regulated technological parameters of the process (V – electrode feed rate, L – electrode extension, U_{xx} – open circuit voltage of the power source, t_{pulse} – arcing time in the pulse, t_p – time of pause, frequency of transferred droplets of electrode metal) and to give the quantitative assessment. This set of process parameters can be optimized at the stage of technological preparation of production, in order to produce a sound welded joint operable under different types of loading. The results of research of the developed mathematical models of melting and metal transfer with systematic short-circuiting of the arc gap during the pulsed welding process, using a computer experiment, permits to evaluate the influence of technological and energetic parameters complex of the process on the penetration of the weld metal, the shape, and sizes of the weld and heat-affected zone; and to predict strength properties and quality of welded joints.

KEYWORDS: computer-aided design, numerical simulation, optimization, adaptive algorithm of pulsed control, welding, arc