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Numerical Simulation of Initiation of SHS Reactions in a Powder Mixture in a Gap between Heat-conducting Metal Sheets

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ABSTRACT

A mathematical model for in-depth fusion of metal sheets joined by laser welding is described in the paper. The model is based on a physicochemical mechanism of fusion of the welding joints with the use of the energy of chemical interaction of high temperature synthesis (SHS) powder systems. The reacting mixture placed in a narrow gap between two heat-conducting sheets is initiated by a focused laser beam moving continuously along the boundary between the sheets. Numerical simulations yield a spatial distribution of the temperature field in a chemically active zone and in the metal proper, as well as the position of the inner fusion boundary and the shape of the fused region. The power of the laser radiation and physicochemical properties of the reacting powder necessary to ensure a sufficient magnitude of welding velocity and fusion depth are determined. The computational experiments performed made it possible to theoretically justify the possibility of laser SHS welding of aluminum sheets in a stable regime with the velocity of the gasless combustion front in the powder mixture not exceeding the welding velocity.

Keywords: laser beam, welding, metal sheet, depth fusion, mathematical model.