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Effect of beam profile on heat and mass transfer in filler powder laser welding

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Abstract:

A three-dimensional transient heat and mass transfer model for laser-powder coupling is created based on the lumped parameter method. A super-Gaussian beam model that is closer to the fiber laser beam profile for welding is employed instead of a frequently-used Gaussian beam. A beam characteristic parameter identification method is proposed to identify the beam characteristic parameters such as the focal spot radius and Rayleigh length. The spatial distribution of the beam power density is reconstructed. The super-Gaussian beam model has a better goodness-of-fit index than the Gaussian beam model. Finite difference method is used to solve the heat and mass transfer model developed. Some powder particles, under the action of three types of laser beams, have evaporated before falling into the laser-induced pool. The average heating rate for the super-Gaussian beam and non-ideal Gaussian beam is lower than that of the ideal Gaussian beam. Although the heated powder distribution zone and the melted powder distribution zone on the workpiece surface for the super-Gaussian beam are larger, the maximum powder mass loss by