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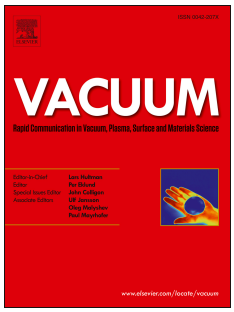

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Modeling fluid dynamics of vapor plume in transient keyhole during vacuum electron beam welding

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Abstract:

In the process of vacuum electron beam welding (VEBW), the vapor plume in the keyhole is one of most important physical phenomena and the flow behaviors of vapor plume in the keyhole play significant roles in determining the quality of the product. However, little knowledge is known about the fluid dynamics of vapor plume in the keyhole during VEBW. In the present study, we first develop a model of the compressible vapor plume dynamics in the keyhole during VEBW process, and investigate the fluid dynamics of vapor plume inside transient keyhole in the VEBW process of Ti-6Al-4V alloy. The characteristic flow patterns of vapor plume are numerically observed and systematically discussed for the first time. The simulation results reasonably agree with the experimental and literature data. The results show that the distributions of vapor plume velocity in the keyhole are high uneven and flow directions vary over time. The maximum velocity can reach more than 1500 m/s. As the power of process grows (1.5 kW~3 kW), more violent flow of vapor plume with complex flow directions are observed. The present study can provide a better understanding of the vapor plume dynamics inside transient keyhole during VEBW.

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