A Phase Field Approach to Model Laser Power Control in Spot Laser Welding

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Abstract

Spot laser welding is largely used in industrial manufacturing, especially in the case of small penetration depth. Unfortunately, welded joins are often polluted by porosities.

The formation of porosities depends on complex thermo-hydraulic phenomena. During the interaction, a deep and narrow cavity - called the keyhole - is formed. At the end of the interaction, surface tension forces provoke the collapse of the keyhole, and gas bubble can then be trapped into the melting pool. These bubbles can bring about residual porosities according to the solidification time.

In order to determine the operating parameters leading to defect free joins, a model has been developed to simulate both the interaction and the cooling stages. The model is based on the Phase Field method in order to apprehend the evolution of the liquid-gas interface shape. The numerical results have been compared to experimental characterizations for different materials (tantalum and Ti6Al4V). The beneficial effect of the laser power control (pulse shaping) has been demonstrated.