# Comparison Between Phase Field and ALE Methods to Model the Keyhole Digging During Spot Laser Welding

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## Abstract

Nowadays, spot laser welding is a full fledged part of industrial manufacturing and is routinely used due to its advantage. It generates very located temperature gradients, and therefore, induces small distortions in the pieces.
Nonetheless, many welding tests are often performed in order to choose operating parameters leading to a narrow heat affected zones and defect-free joins.
This numerical study aims to increase our understanding of the link between operating parameters and the thermo-hydraulic evolution in the welding area, in the case of an isolated impact made with a Nd:YAG pulsed laser on a thin Ti6Al4V sheet. COMSOL Multiphysics® is used to model both the interaction stage and the cooling one.
The present study is focused on the interaction stage. The dependence between the interface temperature and the recoil pressure is taken into account by an adaptation of the Clausius-Clapeyron law. As a first approach, the free surface evolution has been precisely described by a moving mesh method (ALE method), by imposing the recoil pressure and the energy deposition as boundary conditions. The results have been compared with the ones obtained by a fixed mesh method (Phase Field method). The main phenomena are then expressed as volume forces, dependent on the Phase Field variable $\Phi$. Numerical calculations have been compared to experimental characterizations (melted zone shape), in the case of relatively low laser power (inferior to 1000 W).
The confrontation with experimental data has been used to evaluate the accuracy of each method.