Optimization of Welding Parameters Using 3D Heat and Fluid Flow Modeling of Keyhole Laser Welding

S. Gaied[1], M. Courtois[2], M. Carin[2], P. Le Masson[2]

[1]ArcelorMittal Global R&D, Montataire, France
[2]Univ. Bretagne-Sud, Lorient, France

Abstract

A Laser-welded blank (LWB) consists of steels of different thicknesses and/or grades welded together to produce a single blank prior to the forming process. LWB are mostly used in the automotive field where the high productivity of the laser welding process is an advantage. Numerical modeling of the welding process could be a way to optimize the energy input and the quality of LWB, by taking into account the Laser source definition.

It is very important to determine the physical phenomena responsible for welds geometries and its defects during laser welding. For that purpose, a model has been developed in order to offer an adaptive and predictive tool, using the commercial code COMSOL Multiphysics® software. The model takes into account the three phases: the vaporized metal in the keyhole with the plume generation, the liquid metal in the melt pool and the surrounding solid base metal. Modeling the vaporization effects and the keyhole instabilities requires specific numerical methods and developments.

The final goal is to develop a simulation tool providing:
1. A fundamental understanding of the physical phenomena that play a role in keyhole laser welding
2. The fluid flow around the keyhole and its effect on the weld stability
3. The weld seam geometry and its defects

In parallel to the numerical models, we developed experimental competencies to measure physical phenomena and validate the models including temperature field in welds and high speed vision of welding processes.