Abstract

Laser welding properties, such as high precision, low welding distortions and high speed have made this technique very successful in the automotive industry.
In some components however, as in pumps or electronic fuel injection systems, which are always subjected to higher pressures and higher precision, miniaturization and performance is being more and more demanded. In order to respond to such demands, simulations are often used.
The simulation of laser beam welding allows a good understanding of the thermo mechanical phenomena involved and helps finding methods of optimization for the process, saving a great deal of work and expense on experimental tests.
With simulations it's possible to study distortions and residual stress after the welding process in order to minimize them. Furthermore the knowledge of residual stresses, makes the properties of the joints during the component lifetime easier to foresee.

The goal of the dissertation was to develop and test a complete simulation tool of temperature, mechanical distortions and deformations in laser beam welding, combining the already existing models and methods and solving the problems not covered yet by literature.

A new method of implementing the absorbed heat distribution into the FE-Model has been implemented. The method has been proved to ameliorate the precision of the simulation and the advantage of simplifying its use.

An interpolation procedure allowed the implementation of the new STAAZ model, which ameliorates the description of the steel properties changes caused by the steel microstructure transformation during welding temperature cycle. Satisfactory experimental results have been achieved.

The dissertation also provides the user with the capacity of valuating how important the physical phenomena occurring are, which are the relevant input parameters and how to interpret the problems of no convergence.

The results of the dissertation are implemented in the welding simulation tool at Robert BOSCH GmbH.