A Thermo-Mechanical FEM Approach to Laser Transmission Welding of Metal to Polymer

Mayuri Baruah
Department of Production and Industrial Engineering, National Institute of Technology Jamshedpur, Jharkhand, India

Abstract

Laser Transmission welding (LTW) is a crucial method for combining disparate materials, like metals and polymers, particularly in the production of lightweight and hybrid components. However, developing strong and dependable joints is difficult because to the substantial mismatch in thermal and mechanical properties of these materials. The absorbing component (metal) absorbs the laser energy in a thin layer. Heat is produced at the contact as a result of the metal's thin layer melting, and a weld is produced with the right clamping pressure. The LTW process for metal-to-polymer joints is modeled and analyzed in this work using a thermo-mechanical Finite Element Method (FEM) technique. All physical phenomena related to the LTW process, including heat radiation, thermal conduction, and convection heat losses, were taken into consideration during the numerical simulation, which was carried out using ABAQUS. The transient thermal field and the development of thermal stresses during and after welding are simulated by the model using coupled heat transfer and stress analysis. The temperature distribution, weld shape, and residual stress profiles are accurately predicted by the FEM results when they are compared to experimental data taken from Independent literature. The created model offers useful information for enhancing weld quality and process parameter optimization in metal–polymer LTW applications.

Keywords

Laser Transmission welding, Finite Element Method, hybrid components, heat transfer and stress analysis.