

Preface

Laser forming and welding processes can meet the industry demands associated with advantages such as precision of operation, low cost, and local treatment. Although the process is involved with multi-physics phenomena, which is complicated in nature, the proper selection of the process parameters minimizes the process complications and provides high end product quality. High laser power requirements of the process trigger the phase change and high temperature gradients forming in the irradiated region. This is unavoidable because of the requirement for deep penetration of the laser beam into the substrate material to achieve improved case depths during the process. High power laser heating involves solid phase heating, melting, and subsequent evaporation at the surface. Since the laser heating process is fast, the formation of high temperature gradients in the neighborhood of the heated region is inescapable and it becomes crucial for high power laser processing. The formation of high stress levels due to the presence of high temperature gradients causes the failure of the process through crack formation in the irradiated region. In addition, the defect sites formed in the workpiece, due to excessive heating, limit the practical application of the laser processing due to resulting low end product quality. To achieve the required case depth in the substrate material while avoiding the defect sites due to excessive heating, the model study comprehending the heating process becomes necessary. In addition, the model study provides physical insight into the process and gives information about the influence of process parameters on the end product quality. Although the analytical treatment of the heating process involves some useful assumptions to minimize the mathematical complications, the findings are important to correlate the dependent variables with the independent process parameters. However, the number of assumptions may reduce for the numerical simulation of the heating process at the expense of considerable computational efforts. On the other hand, the predictions of numerical simulations and the result of analytical solutions are not sufficient to make a precise assessment of the process. Consequently, experimental investigation of the laser heating process becomes essential to validate the predictions for sound assessments, despite the high cost and difficulties faced during experiments.

In this book, laser forming and welding processes are presented in detail. The analytical and numerical approaches for the predictions of temperature and stress

fields in the irradiated region are presented during the heating and cooling cycles of the process. The thermal efficiency of the welding process is also included to extend the thermodynamics analysis associated with the process. Experimental findings and observations are included to explore the metallurgical and mechanical characterizations of the regions treated by using laser processing pertinent to forming and welding of the metallic substrates. Although this book covers most of the aspects of forming and welding processes, it is not claimed to be complete and is open for further improvements in the next editions.

Laser Forming and Welding Processes

Yilbas, B.S.; Akhtar, S.; Shuja, S.Z.

2013, X, 106 p. 48 illus., 6 illus. in color., Hardcover

ISBN: 978-3-319-00980-3