Chapter 5
Metaheuristic Techniques–Based Optimizing Laser Welding Parameters for Copper–Aluminum Alloys

Satyanarayana Tirlangi
http://orcid.org/0000-0001-8265-8743
Visakha Institute of Engineering and Technology, Visakhapatnam, India

T. S. Senthil
http://orcid.org/0000-0001-9580-0286
Noorul Islam Centre For Higher Education, Kumaracoil, India

S. John Leon
Noorul Islam Centre For Higher Education, Kumaracoil, India

A. Parvathi Priya
RMK Engineering College, Thiruvallur, India

Raghuram Pradhan
PACE Institute of Technology and Sciences, India

Ramya Maranan
http://orcid.org/0000-0003-1001-3422
Lovely Professional University, Punjab, India

ABSTRACT

In this research endeavor, the laser welding of C63000 alloy has been thoroughly examined, focusing on the interplay of key welding parameters—laser power, welding speed, and amplitude. The experimental design, structured as per the Taguchi L9 array, provided a systematic approach to investigating these parameters' effects on critical mechanical properties, specifically tensile strength and Brinell hardness.

DOI: 10.4018/979-8-3693-3314-3.ch005

The alloy's responses were meticulously studied under varied conditions, capturing the nuances of its behavior in response to changes in laser welding inputs. The experimental outcomes revealed distinct trends in tensile strength and Brinell hardness in relation to the variations in welding parameters. Notably, the highest levels of tensile strength and hardness were consistently observed under specific combinations of welding speed, laser power, and amplitude.

INTRODUCTION

Laser welding is a commonly employed method in numerous sectors owing to its accuracy and efficiency (Mehta et al., 2023; Siddiqui et al., 2023). Copper-aluminum alloys, in particular, have attracted substantial interest owing to their unusual mix of characteristics (Ragumadhavan et al., 2023; Sasi et al., 2023). However, getting good mechanical characteristics in laser-welded copper-aluminum alloys requires careful tuning of welding conditions (Lakshmaiya, 2023h; Sukumaran et al., 2023). This literature review seeks to analyse the present status of research on optimizing laser welding settings to optimise the mechanical characteristics of copper-aluminum alloys (Natrayan & Richard, 2023b; Rajasekaran & Natrayan, 2023b).

Effects of Laser Power: The laser power employed in welding considerably effects the mechanical qualities of the welded connection (Lakshmaiya & Murugan, 2023d; Selvi et al., 2023). Several research have explored the influence of laser power on the microstructure and mechanical characteristics of copper-aluminum welds (Kaliappan, Natrayan, & Garg, 2023; Natrayan, Kaliappan, Saravanan, et al., 2023). Higher laser power typically leads to deeper penetration and quicker solidification rates, leading in higher tensile strength and hardness (Kaliappan, Mothilal, et al., 2023; Lakshmaiya, 2023a). However, high laser power may also create flaws like as porosity or cracking (Balamurugan et al., 2023; Josphineleela, Kaliapp, et al., 2023). Therefore, choosing the correct laser power is critical to obtain the necessary mechanical characteristics. Welding speed is another significant element influencing the mechanical characteristics of laser-welded copper-aluminum alloys (Josphineleela, Lekha, et al., 2023; Loganathan et al., 2023; Reddy et al., 2023). Higher welding rates tend to lower the heat input and solidification time, resulting in finer microstructures and higher mechanical characteristics (Lakshmaiya, 2023f; Natrayan & De Poures, 2023). However, too high welding rates may lead to partial fusion or diminished joint strength. Therefore, the welding speed must be carefully tuned to balance the solidification rate and joint quality (Kaliappan, Natrayan, & Rajput, 2023; Kaushal et al., 2023).

Liver Disease Prediction Using Classification and Feature Selection Techniques

S. Abiramasundariand P. Umamaheswari (2025). *Predictive Algorithms for Rehabilitation and Assistive Systems (pp. 335-356).*
www.irma-international.org/chapter/liver-disease-prediction-using-classification-and-feature-selection-techniques/380911