Pre-and-Post Processing of Blue Laser Welded Copper-to-Tin-Coated Steel Applicable for EV-Battery Application

Pratik Shukla[1], Sean Shi Hao Teoh[2], Ioannis Metsios[3], Sanjay Gupta[4], Aurelie Tolten[1], Niroj Maharajan[5], Naien Wu[6], Wei Zhou[2]

1 Ansty Park, The Manufacturing Technology Centre, Ansty Park, Coventry CV7 9JU, United Kingdom. 2 Singapore Centre for 3D Printing, School of Mechanical and Aerospace Engineering, Nanyang Technological University, 50 Nanyang Avenue, 639798, Singapore. 3 Lumpi Ltd, 8a Sun Street, Potton, Sandy, England, SG19 2LR, United Kingdom. 4 Faraday Battery Ltd., W&H Factory Complex, Hay Mills, Fordrough, Small Heath, Birmingham B25 8DL, United Kingdom., 5 Precision Laser Solutions Pte. Ltd, 280 Woodlands Industrial Park E5, #09-39/40, 757322, Singapore

Corresponding author: pratik.shukla@the-mtc.org

The need for high-precision welding of copper has significantly increased with the electrification boom. Laser welding has emerged as a promising technique for achieving precise welds particularly with joining copper with dissimilar material [1]. However, achieving high-quality welds presents distinct challenges due to the high reflectivity of copper to infrared lasers [2]. This work investigates the welding of a Commercially available copper alloy (C106) of 0.9 thickness blue laser welded to tined steel stainless steel of 0.3 mm thickness respectively were used for the experiment, using a 1.5 kW, 450nm continuous-wave (CW) blue laser. To enhance weld quality, a pre- and a post process was introduced in form of green (532nm) laser cleaning, welding, and post-weld laser shock peening (LSP) using 532nm wavelength with an ultra-portable laser shock processing system. The experiments involved welding 0.9 mm thick copper to 0.4 mm thick stainless steel. Key findings revealed that laser cleaning increased the copper surface roughness by about 50% by removing impurities and oxidation. Blue laser welding enhanced surface hardness, but introduced defects such porosity and cracks especially as it was a spot weld, affecting weld quality. Despite these issues, some welds exceeded the required shear strength of 220 MPa. In addition, laser peening improved grain structure and hardness but did not notably enhance shear strength. The combination of laser cleaning and welding produced the best results, highlighting the importance of surface preparation. Further studies should investigate varying laser intensities and methods to improve residual compressive stresses.

[1] Pratik Shukla, Sean Shi Hao Teoh, Ioannis Metsios, Sanjay Gupta, Aurelie Tolten, Niroj Maharajan, Naien Wu, and Wei Zhou, (2024), Blue laser welding of copper-to-stainless steel and its pre-and-post processing for battery joining application, Journal of Laser Applications, Submitted on 22nd August 2024, Accepted on minor corrections.

[2] Hummel, M., Schöler, C., Häusler, A., Gillner, A., Poprawe, R. (2020) New approaches on laser micro welding of copper by using a laser beam source with a wavelength of 450 nm, Journal of Advanced Joining Processes, 1, 100012, 7 Pages. [3] A. Author (year) Title of book (Publisher), Chapter.