Copper Welding with High Brightness, Adjustable Ring Mode (ARM) Fiber Lasers

Introduction

Despite their widespread use in welding, fiber lasers have not been optimum for welding copper or other metals that are highly reflective at their infrared output wavelength. This report examines using a new type of adjustable ring mode (ARM) fiber laser having a high brightness center beam for copper welding.

Process

Coherent HighLight ARM lasers feature an infrared output beam consisting of a central spot, surrounded by another concentric ring of laser light. They are available with various center-to-ring ratios and power levels. Here, a high brightness center diameter of 22 µm, and a ring beam with an inner diameter/outer diameter of 100 µm/170 µm was used. A remote processing head at a magnification of 1.4 was employed, with nitrogen as shielding gas and cross jet. Laser power was 4 kW (1.5 kW center and 2.5 kW ring). The copper substrates were welded at different processing speeds, and all welds were produced at full laser power. The focus position was varied and best weld quality (in terms of spatter and surface quality) occurred at a focus position 1.5 mm above the material surface.

Results

This ARM laser provided better results for copper welding than traditional fiber lasers for two key reasons. First, the high brightness center beam produces a higher power density than a standard fiber laser of the same output power, and this efficiently initiates keyhole formation. Second, the ring beam serves to stabilize the keyhole. This prevents its collapse, and reduces resultant weld porosity and spatter.

The experimental data (Figure 3) show that high brightness adjustable ring mode (ARM) fiber lasers can weld copper at 12 m/min (200 mm/s), at 1 mm weld depth, using 4 kW of laser power. The ARM laser is thus an excellent solution for demanding copper welding applications in the e-mobility space. Weld penetration, weld cross section and process speed match or exceed current production requirements of the customer for whom this testing was performed.

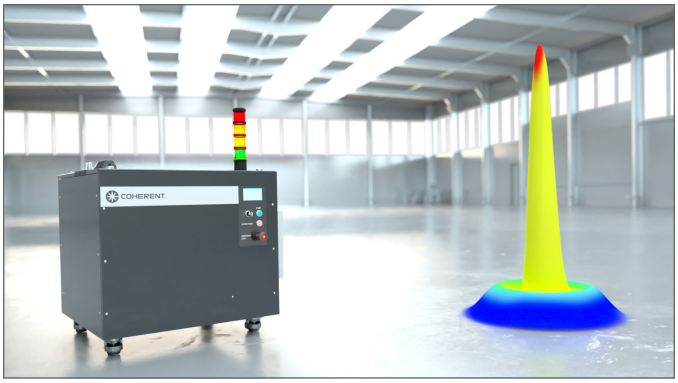

Figure 1. HighLight FL4000CSM-ARM fiber laser

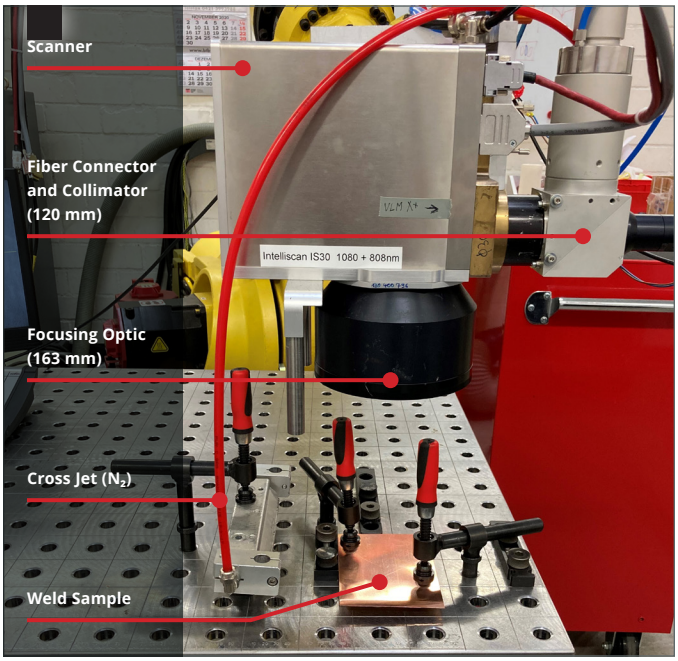

Figure 2: Single mode ARM fiber laser weld station with scanner and shielding nozzle

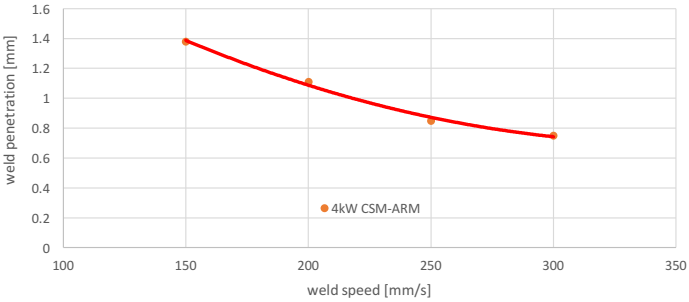

Figure 3: Weld curve for 4 kW single mode ARM, weld penetration over weld speed

Application Field

Laser welding of copper.

Contact

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