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Present State and Trend of Laser Welding Technology

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Laser welding technologies have been greatly developed in several fields. High power fiber and diode lasers are now commercially available at the powers of 120 kW and 60 kW, respectively. In welding with high power lasers, hot cracking occurred in deeply-penetrated welds [1, 2]. Such hot cracks could be reduced by welding in low vacuum, at the defocused distance, or with the utilization of flux placed on the plate surface. Nowadays, the development of higher power green high-harmonic lasers or blue diode lasers is expected for stable welding of copper. The present great issue of laser welding is occurrence and reduction in spattering. Spatters occurred in the front, side and rear of a keyhole, depending upon low, middle and fast welding speed, respectively. Good lasers with proper beam modes for reduction in spattering have been developed by several companies. As shown in Fig. 1, spattering was suppressed by stable welding with an ARM beam mode laser, although a single beam laser induced spattering severely. Spattering could be also reduced in welding in low vacuum, with the use of a single mode laser with a small beam diameter, or under the conditions of defocused distance (of a focal point beneath the plate surface). In addition, a slow rise in an output power for the formation of a molten pool with an ample melt before the formation of a keyhole should be recommended to reduce spattering at the initial start stage of welding. Establishment of laser welding of dissimilar metals between steel and aluminum alloy or copper and aluminum, or dissimilar materials of metals, plastics and CFRP is expected. Strong weld joints could be formed. Concerning monitoring, the measurement technique of keyhole depths during laser welding with OCT (Optical Coherence Tomography) was being established.

(a) Beam mode of ARM laser (b) Laser welding with ARM laser (c) Laser welding with normal laser

Fig. 1. ARM laser beam mode with center and ring powers, and comparison of molten pool and keyhole behavior during welding of A6XXX aluminum alloy with ARM laser and normal laser.

References

[1] S. Katayama, et al.: “Fundamental Research of 100 kW fiber laser welding technology”, LiM 2015.
[3] U. Reisgen, et al.: “Welding of high thickness steel plates using a fiber coupled diode laser with 50 kW of output power”, LiM 2017.