Upscaling laser welding with beam shaping

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Laser material processing has become a cornerstone of modern manufacturing, enabling high-precision operations across a wide range of industries. For decades, the evolution of laser technologies has driven the upscaling of the laser processing market and its innovations. Beam shaping is now emerging as a critical innovation to further enhance laser processing, offering superior control over energy distribution and enabling exceptional performance in diverse applications. This paper presents the advantages and capabilities of Multi-Plane Light Conversion (MPLC) advanced beam shaping solutions in improving laser welding processes.

The rapid growth of the electric vehicle (EV) market is driving innovation, particularly in addressing challenges in laser welding of copper and aluminium. These materials present significant welding challenges, requiring stringent control over porosity and spatter. Advanced beam shaping modules leveraging MPLC technology have been developed to meet these challenges. The beam shaping is achieved with two integrated mirrors placed between the collimation block and either a focusing block or a scanner. MPLC technology provides unparalleled flexibility in beam shaping, offering a depth of field four times greater than dual-core technologies, thereby simplifying implementation.

The presentation will showcase the benefits demonstrated in welding real EV components. We will first discuss cell contacting, illustrating how beam shaping can replace wobbling and significantly reduce processing time. Next, we will examine various busbar welding configurations. On one hand, we will analyse the impact of beam shaping on welding busbars with gaps, and on the other, its performance in complex configurations, such as low-speed welding. Lastly, we will explore the effects of beam shaping on hairpin welding, focusing on its ability to reduce spatter and weld under challenging conditions, such as misaligned hairpins. These analyses will include X-ray imaging, macrographs, and high-speed video analyses in various configurations. We will then reflect on the industrial impact of these advancements and demonstrate how beam shaping is effectively enabling significant upscaling within the industry.

Finally, we will discuss future perspectives: ongoing developments in beam shaping technology, broader industry trends, and upcoming challenges to address.

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