Fully reflective annular laser beam shaping for 1.03µm ultra-high throughput laser beam welding

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Multi-kilowatt laser-based macroprocessing applications, including Laser Beam Welding (LBW), are numerous among all fields of industry, ranging from automotive and naval to aerospace. LBW processes are nowadays evolving to face new challenges: reducing final parts weight and increase process efficiency and robustness to avoid waste. Shaping of the laser beam is key for such improvements of LBW processes whilst enabling welding of new types of material and thinner parts, reducing parts overall weight.

Dealing with high-power lasers requires specific designs to evacuate heat in order to maintain performance over a long time. We describe here a fully reflective beam shaper, which allows high efficiency cooling of all optics during processing. The focus shift inherent to most LBW processes is highly reduced thanks to the absence of thermal gradient inside the optics in opposition to transmissive optics, leading to better beam stability and process. The shape onto the processed part is a mm-wide annular shape with a high control of phase and intensity, permitting control of width and depth of the melt pool.

This system is integrated as a compact laser head on a robot arm in order to allow LBW of complex parts. We describe the main features of the beam shaper and demonstrate its capability to work properly and safely at high power, from multi-kW to up to 16kW, with high stability even for very long processing times. The process test results and the weld quality improvements are described for different materials.