Testing a Photodiode-based Sensor Integrated to a Dynamic Beam Shaping Laser System for In-process Detection of Part-to-Part Gap and Weld Penetration Depth

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Advancements in dynamic beam shaping has the potential to revolutionise the laser welding process by offering free-shape beam shaping and shape sequencing, modulated at speeds up to tens of MHz. The introduction of such fast modulation in time and space can be used to influence the melt pool dynamics and the microstructure, hence achieve superior weld quality. Parallel to this, the rise of digital transformation in manufacturing industries represents a massive opportunity. Clearly, the laser beam welding industry with dynamic beam shaping can, and must, benefit from this. To achieve this goal, more research in welding process development and sensor fusion/integration is urgently needed. This talk will present an in-process monitoring system consisting of a photodiode-based sensor (Precitec LWM) integrated into the CIVAN OPA6 laser system with a pre-focussed optics. The beam delivery was enabled by a fast SmartMove scanner. This is the first time that an in-process weld quality sensor is fitted and tested on the CIVAN OPA6 laser system. To demonstrate this approach and motivated by the high variability during the welding process of 6061 aluminium sheets, the talk will show the results of an extensive experimental campaign aimed at detecting variation in weld penetration depth and part-to-part gaps in laser welding of 6061 aluminium sheets (0.4 mm to 0.8 mm thickness) in overlap configuration. The talk will then conclude with the current developments in automatic classification of defective welds based on supervised machine learning.