Remote Laser Welding of Die-cast Aluminium Parts for E-mobility Applications with High Frequency Beam Oscillation and Beam Shaping

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Although significant research already exists mapping current joining technologies to manufacturing readiness levels, there is a significant gap in understanding needs and requirements for manufacturing of structural components for e-mobility applications. Among all, the battery tray is the interface between the underbody structure and the road for the housing of battery packs. Its design implies high engineering complexity with multiple requirements such as water/gas tightness, strength, weight distribution and cooling of high-voltage circuits. Owing to the excellent flexibility and cost affordability, aluminium die-cast materials are frequently used in a number of critical areas such as corner nodes, front and rear rails and interface blocks with the vehicle structure. The selection of the joining processes is a challenging task which must account for both technical performances (i.e., strength and sealing of the joints) and manufacturing costs. Remote Laser Welding (RLW) is fast becoming a key process due to its competitive processing speed, less restrictive single-sided access requirements and improved process flexibility. Die-cast components have limited or no weldability due to entrapped gases which generate pores or cavities. Therefore, the interaction time between laser beam and material as well as the heat balance have to be carefully controlled to reduce the porosity level and hence achieve the desired joint integrity and durability.

This paper aims at providing a view on the selection of the welding equipment in terms of beam oscillation, power modulation and beam shaping, and demonstrate the development of the process parameters for two sets of dissimilar aluminium alloys: (1) sheet metal Al (AC170) to Al casting (C611); and, (2) Al casting (C611) to Al extrusion (AA6063). Experimental data shows that the porosity level can be significantly reduced by the combination of high frequency beam oscillation and the dual beam welding with novel Adjustable Ring Mode (ARM) laser. High speed images, metallographic analysis and mechanical tests are used to validate the process and provide thoughtful insights about the dynamics of the molten pool.