Insight into the alternative galvanic corrosion behaviors of the laser-arc hybrid welded magnesium/aluminum dissimilar joints

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Abstract In this study, an effective 6061/AZ31B lap joint was successfully produced using laser-arc hybrid welding with beam oscillation and a Ti interlayer. The formation and corrosion mechanism of the weld joint (WJ) were thoroughly investigated through electrochemical and microstructural characterizations. The joint exhibited a defect-free surface and an enhanced lap interface width due to beam oscillation, with an Al/Mg interdiffusion layer containing Al3Ti phases. Corrosion studies revealed that the AZ31B region experienced the most severe corrosion, followed by the WJ and the 6061 regions. The superior corrosion resistance of the WJ was attributed to its microstructural differences and the uniform distribution of Al-Mn phase, which minimized micro-galvanic corrosion. Over time, a cathode-anode exchange occurred, with the Al region becoming the anode and the Mg region becoming the cathode. This exchange was driven by a dense corrosion product layer on the Mg region and the dissolution of the oxide film on the Al region as pH increased, leading to periodic shifts in the Al region to an anode state, thus accelerating its corrosion.