Remote laser welding of Zn-coated steel to aluminium – A study on the effect of Zn vaporisation and subsequent corrosion behaviour

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Abstract

Remote Laser Welding (RLW) presents an advanced technique for joining dissimilar metals such as steel and aluminium, which are vital in industries focused on weight reduction and high mechanical performance. However, welding steel to aluminium poses significant challenges, particularly due to the formation of intermetallic compounds (IMCs) and the vaporisation of Zn when a Zn-coated steel is used. Although an extensive body of experimental and modelling work has shown the mechanisms behind the IMC formation and related properties, limited research has shown the complex interplay with vaporisation of Zn. Zinc, with its relatively low vaporisation temperature, easily vaporises during the welding process, forming high-pressure vapour pockets. This can lead to weld defects such as porosity, spattering, and lack of fusion, while also intensifying the formation of brittle IMCs. These defects compromise the integrity of the weld, reducing the overall strength of the joint. Moreover, the corrosion resistance of dissimilar steel-aluminium joints is a major concern. This material pairing is particularly susceptible to galvanic corrosion, which can undermine the advantages of lightweight construction and weaken the welded structure. Understanding the corrosion behaviour of these joints is crucial for ensuring reliable real-world applications. Addressing these challenges, this study investigates the effects of Zn vaporisation and IMC formation on the mechanical properties of the welded joints. Additionally, it highlights the corrosion behaviour of the welded parts, providing insights into the long-term performance of RLW steel-aluminium joints and their suitability for industrial use.