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Seam Edge Properties of Laser Brazed Zinc Coated Steel Substrates

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Abstract

Laser brazing is significant in terms of enabling high precision car-body design with numerous fine details in body-in-white structure, owing to how this joining method works. Using a laser as the heat source enables melting of the filler metal with high precision which gives a thinner braze seam compared to other methods such as gas metal arc brazing (GMAB). Although it has been proven that laser brazing enhances the joint seam appearance by providing narrower fusion zone, several challenges must be addressed to optimize the mechanical performance of the joints. These challenges include: (1) chemical reactions at the interface between the substrate and filler metal form various intermetallic compounds (IMCs) that result in different hardnesses; (2) microstructural features including IMC geometry, dendritic structure of the solidification zone, and grain structure at the joint seam affect subsequent deformation behavior; (3) possible defects including pores, inclusion, and lack of adhesion can act as crack initiation sites and micro-cracking that promote early crack propagation; (4) melting of substrate which alters mechanical properties of the base metal by undesired softening. A new debate in this area is to monitor braze seam quality via the wetting profile by taking two factors into account: (1) the wettability of the filler material on the substrate, and (2) the brittleness of wetting profile especially at the edges that act as crack initiation sites. In this study, laser brazing of different types of zinc coated (*i.e.*, hot-dip galvanized (GI) and galvannealed (GA)) advanced high strength steels (AHSS) was conducted in the bead-on-plate (BOP) configuration which showed sharp Zn rejection from the coating into the molten Si-bronze (CuSi3Mn1) filler material at the wetting profile edges resulting in tail-like edge geometry in both cases. Whereas in GMAB Zn rejection and tailing-out only occurred in GI but not GA, thereby GI had better wetting quality. Although the tail size of the BOP by laser on each coating was observed to be different, the wetting behavior of GI and GA steels became similar. Moreover, Zn penetrated the seam in both cases without much porosity. It was found that the braze seam melted and thereafter solidified, which might occlude Zn porosity from trapping Zn vapour in the solidified braze, but this was not observed. It is worth mentioning that by having lower porosity, better joint mechanical performance is expected.