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Effect of Ageing of Laser-Treated Surfaces on Corrosion Resistance of Fusion-bonded Al Joints

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Abstract : Aluminium has been used in a wide range of industrial applications due to its numerous advantages, including excellent specific strength, thermal conductivity, corrosion resistance, workability and recyclability. The automotive industry is increasingly adopting multi-materials, including aluminium in structures and components to improve the mechanical usability and performance of individual components. A common method for assembling dissimilar materials is mechanical joining, but mechanical joining requires multiple manufacturing steps, affects the mechanical properties of the base material and increases the weight due to additional metal parts. Fusion bonding is being used in more and more industries as a way of avoiding the above drawbacks. Infusion bonding, and surface pre-treatment of the base material is essential to ensure the long-life durability of the joint. Laser surface treatment of aluminium has been shown to improve the durability of the joint by forming a passive oxide film and roughening the substrate surface. Infusion bonding, the polymer bonds directly to the metal instead of the adhesive, but the sensitivity to interfacial contamination is higher due to the chemical activity and molecular size of the polymer. Laser-treated surfaces are expected to absorb impurities from the storage atmosphere over time, but the effect of such changes in the treated surface over time on the durability of fusion-bonded joints has not yet been fully investigated. In this paper, the effect of the ageing of laser-treated surfaces of aluminum alloys on the corrosion resistance of fusion-bonded joints is therefore investigated. AlMg3 of 1.5 mm thickness was cut using a water-jet cutting machine, cleaned and degreased with isopropanol and surface pre-treated with a pulsed fiber laser at a wavelength of 1060 nm, maximum power of 70 W and repetition rate of 55 kHz. The aluminum surfaces were then stored in air for various periods of time and their corrosion resistance was assessed by cyclic voltammetry (CV) and electrochemical impedance spectroscopy (EIS). For the aluminum joints, induction heating was employed as the fusion bonding method and single-lap shear specimens were prepared. The corrosion resistance of the joints was assessed by measuring the lap shear strength before and after neutral salt spray. Cross-sectional observations by scanning electron microscopy (SEM) were also carried out to investigate changes in the microstructure of the bonded interface. Finally, the corrosion resistance of the surface and the joint were compared and the differences in the mechanisms of corrosion resistance enhancement between the two were discussed.

Keywords : laser surface treatment, pre-treatment, bonding, corrosion, durability, interface, automotive, aluminium alloys, joint, fusion bonding
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