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Microelectrochemical evaluation of severe localized corrosion sites developing on third-generation aluminium alloys

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Third-generation aluminium-copper-lithium alloys exhibit attractive mechanical properties, in particular light-weight and significant strength. However, the developed microstructure often results in severe localized corrosion (SLC) sites with fast in-depth pit propagation accompanied by H_2 evolution.[1] Such phenomena stem from a strong galvanic coupling, mainly established between Fe- and Cu-rich particles and the surrounding matrix. As a result, strong concentration and pH gradients develop throughout the aluminium surface, determining the local breakdown of the passive regime eventually provided by aluminium oxides and corrosion products. Understanding the development of such distributions is key to outline appropriate strategies for the prevention of fast degradation and materials failure.

Scanning Electrochemical Microscopy (SECM) and Scanning Vibrating Electrode Technique (SVET) are capable of providing local information on the distribution of active sites and the presence of reactive chemical species. SVET has previously demonstrated the formation of gas bubbles ascribed to hydrogen evolution (i.e., electro-reduction process) at the anodically-activated sites,[2,3]; whereas local hydrogen production, oxygen consumption and pH changes are readily accessible using SECM, although with some limitations with regards to the detection of evolving gas.[4]

The present contribution reports recent advances in the investigation of local degradation phenomena occurring at the surface of Al-Cu-Li alloy AA-2098, as bare material and after friction stir welding. Oxygen consumption over nobler particles acting as cathodic sites, and SLC accompanied with strong acidification and H_2 production at the local anodes were observed. The determined pH and concentration gradients allow to progress in the knowledge of the mechanistic aspects involved in the degradation processes on these materials.

References

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