Electrochemical Behaviour of Active Surface Layers in Commercial Rolled AA3005 Sheet

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Both the hot and cold rolling that are used in aluminium alloy sheet production result in a high level of enhanced surface shear deformation. This deformed near surface layer has different electrochemical properties and microstructural characteristics compared to the underlying bulk microstructure. (1-2) Filiform corrosion behaviour of aluminium alloys is generally controlled by the presence of this micro-deformed layer at the surface, which results in the precipitation of very fine intermetallic particles during subsequent heat treatment. (3-5)
Electrochemical measurements were carried out on an as rolled and annealed aluminium alloy AA3005 (0.67 mm thick sheet) in 5%NaCl at pH 3.0 and 11.5. The samples were etched to different depths from the surface using GDOES (Glow discharge optical emission spectroscopy) sputtering. (6) The thickness of the deformed layer on the sheet was found to be approximately 1 µm. The anodic and cathodic reactivity of the active surface layer was significantly higher than that of the bulk as shown in Fig. 1 and 2. In agreement with this, image analysis showed an increased number of intermetallic particles at the surface. The corrosion morphology of the surface layer showed that the number of pits was higher than that of the bulk.

Potentiostatic polarisation experiments in 5% NaCl at pH 11.5 showed that the surface passivated at a higher current than the bulk. Anodic polarisation curves in alkaline solution showed that the surface has a slightly lower pitting potential and higher passivation current than the bulk. However, the repassivation behaviour was not much different. The corroded surfaces after anodic polarisation in both pH 3 and pH 11.5 5% NaCl solution showed crystallographic facets and intermetallic particles. In this alloy, there are two main types of intermetallic particles: α-$Al_{12}(Fe,Mn)_3Si$ and $Al_6(Fe,Mn)$. The $Al_6(Fe,Mn)$ phase was found to more cathodic than the silicon α-phase. Immersion testing in 5%NaCl revealed enhanced grooves around $Al_6(Fe,Mn)$ particles.

References

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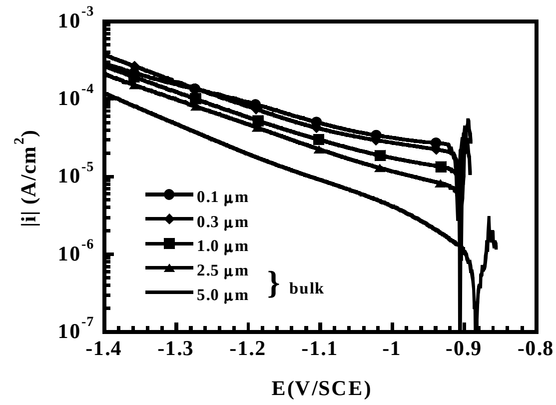

Fig. 1. Cathodic polarisation curves at different depths from the surface of AA3005 sheet in 5% NaCl pH 3

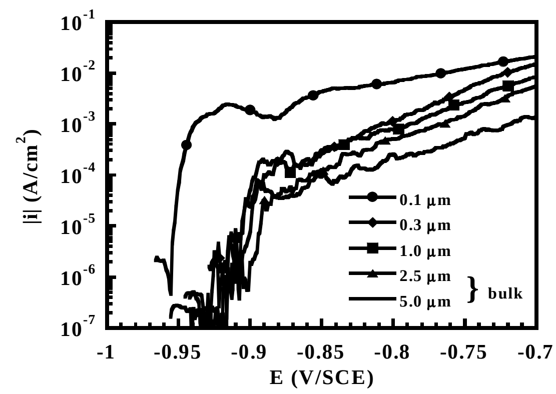

Fig. 2. Anodic polarisation curves at different depths from the surface of AA3005 sheet in 5% NaCl pH 3

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