Effect of Trace Elements on Electrochemical Behaviour and Pitting Corrosion of Aluminium

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Earlier work [1] has shown that high temperature heat treatment, *i.e.*, heat treatment at temperatures above 400°C, results in poor resistance to filiform corrosion (FFC) for certain wrought aluminium alloys in the AA3000 and 8000 series. This poor FFC resistance was attributed to the presence of an electrochemically active surface layer, as indicated by a deep negative potential transient when exposed to an acidified chloride solution. The cause of surface activation is however poorly understood. The purpose of this work was to study the effect of high temperature heat treatment on aluminium alloy AA3102, which is commonly used for heat transfer applications, and three model alloys with improved corrosion resistance by utilizing surface-analytical (*e.g.*, GD-OES) and electrochemical methods. In addition, various binary model alloys were studied in order to better identify the cause of surface activation.

Samples were heat-treated for 5 to 120 min at temperatures in the range 300 to 600°C in an air-circulating furnace and subsequently quenched in distilled water at room temperature. Quantitative depth profiling was performed by using a LECO GDS-750 glow discharge optical emission spectrometer in the radio frequency (rf) mode.

The results show that alloy 3102 and three model alloys with improved corrosion resistance were electrochemically activated in chloride solution as a result of heat treatment for periods exceeding 10 min at temperatures higher than 400°C. The electrochemical activation was determined by the presence of deep negative potential transients when exposed to an acidified chloride solution, as shown in Fig. 1. Furthermore, the anodic current densities became large at a given potential relative to the as-extruded surface as a result of high temperature heat treatment as shown in Fig. 2. The activation phenomenon was attributed to enrichment of the surface by Group IIIA or IVA metals, in particular lead, which was present in the materials as a trace element (Fig. 3). Studies of a series of binary model alloys confirmed the activating effect of lead even when present in trace amounts. The effect of alloying with Group IIIA and IVA elements on activation of aluminium is well documented [2]. The activation phenomenon was related to unidentified interactions between metallic lead and chloride ions, which had a destabilising effect on the oxide. It was also shown that enrichment of the surface by lead had a sacrificial effect in protecting the surface against pitting corrosion.

Acknowledgments

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References

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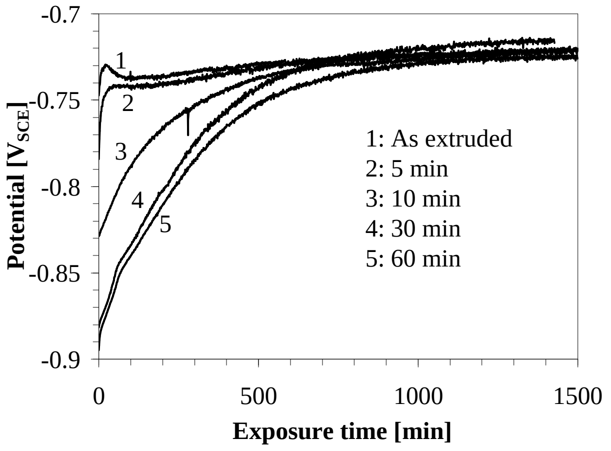

Fig. 1. Effect of heat treatment time at 600°C on the corrosion potential of alloy AA3102 in acidified seawater.

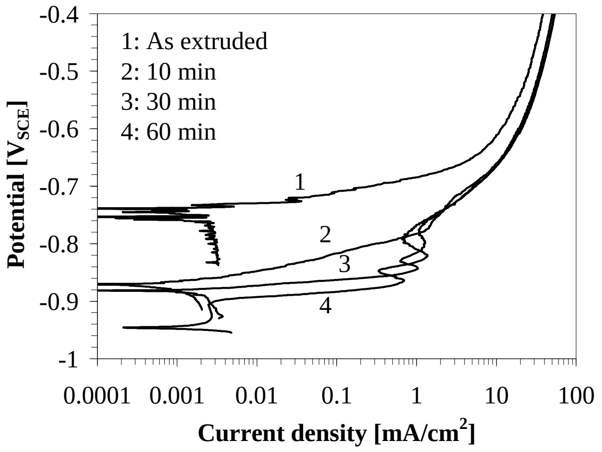

Fig. 2. Effect of heat treatment time at 600°C on the anodic behaviour of alloy AA3102 in 5 wt % NaCl solution.

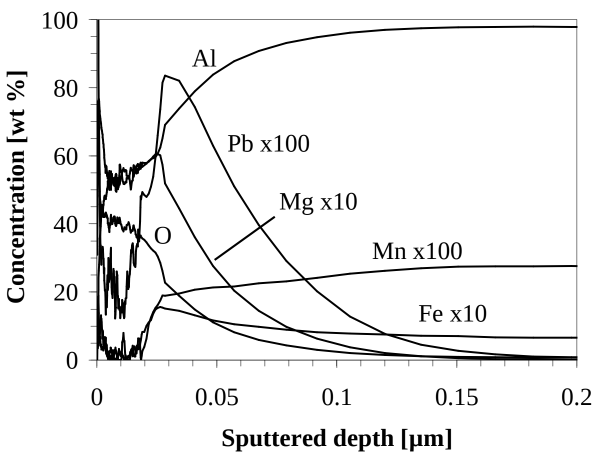

Fig. 3. GD-OES profiles for polished and heat treated (60 min, 600°C) 3102 alloy.