Nanotomography Coupled with RF-GDOES for Evaluation of the Corrosion Performance of Processed Aluminium Alloys

A. Cassell, G. E. Thompson, X. Zhou
LATEST2, School of Materials,
The University of Manchester

It is known that the thermomechanical processing of aluminium alloys by rolling and extrusion significantly alters their microstructures. These microstructures can be beneficial to the mechanical behaviour of the material, but they can also be detrimental to the corrosion properties in real-life situations. In particular, an altered microstructure is developed in the near-surface regions during thermomechanical processing.

The understanding of the corrosion behaviour of a commercially produced aluminium alloy is important for material durability. Employing a technique recently developed at The University of Manchester, nanoscale in-SEM tomography allows the observation of the nanoscale structures developed within the near-surface region of commercially produced alloys. Examples of results are presented in Figures 1 and 2 The information that can be acquired from this technique can quantify changes in the size, shape and distribution of the relevant microstructural features.

During rolling, the altered near-surface microstructure is distributed across the surface by the rolls in a manner that can result in inconsistent distributions of such microstructures. The varying microstructure across the surface can have significantly different corrosion behaviour when compared to the bulk alloy.

Further, it is often difficult to assess the corrosion properties of the commercially produced alloys due to the complex nature of altered near-surface microstructures, which also have altered phase distributions. In particular, contact with the rolls can lead to the incorporation of various hot-formed oxides into the near-surface region. Microalloying of various types of oxides, including those of magnesium, zinc and aluminium, have been witnessed beneath the surface.

Elemental depth profiles of the same commercially produced alloy are provided by radio frequency glow discharge optical emission spectroscopy. Analysis of the first few microns of the rolled surface can provide accurate readings relating to elemental concentrations present within the near-surface region, as shown in Figure 3. Such analysis helps to correlate the corrosion behaviour of the alloy to the distribution of the chemical species in the near-surface region of the alloy.

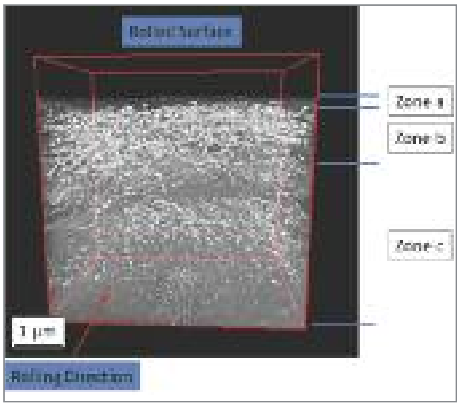

Fig. 1 3D rendering of the volume of the microstructure associated with the near-surface region of a commercially produced AA7xxx alloy, revealing three zones: namely a, b and c, with significantly different microstructures compared with the bulk.

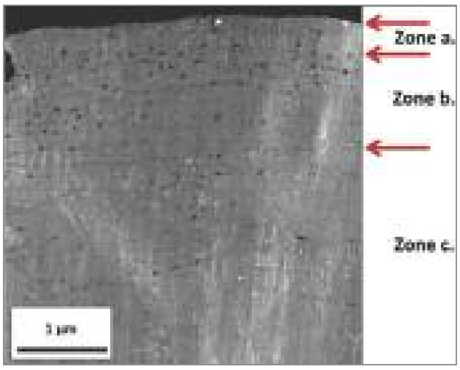

Fig. 2 HAADF micrograph of the cross section of the same near-surface region rendered in 3D in Fig. 1. Features within the zones are readily compared.

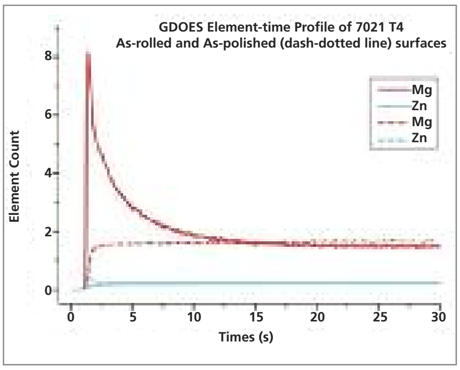

Fig. 3 The elemental depth profiles for magnesium and zinc which contribute significantly to the corrosion behaviour of the alloy. A sputtering rate of 66 nm/s was achieved. Magnesium oxides are present at the surface after rolling.

Acknowledgements: This LATEST2 project was performed with support from Constellium.

Publications: A. Cassell, G. E. Thompson, X. Zhou, T. Hashimoto and G. Scamans. Relating Grain Misorientation to the Corrosion Behaviour of Low Copper 7xxx Aluminium Alloys, Mater. Sci. Forum, 765, 623-628, 2013.