# Morphology of Corrosion Damage in Magnesium Alloys and Anion Effects on Passive Film Stability.

Andrew Fones, Miguel Gonzalez Torreira and Alison J. Davenport

The University of Birmingham
Metallurgy and Materials
Edgbaston, Birmingham, B15 2TT, UK

The need for reduced weight in automotive applications has lead directly to an increased interest in magnesium and its alloys. Magnesium has a very low specific gravity (1.74), but can have a reasonable stiffness compared to aluminum, the other widely used lightweight metal. The materials properties of the alloys used are promising. However, a major factor for automotive applications is the fatigue behavior of the metal, which frequently defines the life of the component. The fatigue properties are dependent on the surface condition of the material.

One of the primary sources of damage to the surface of metals is corrosion. This is particularly true in magnesium as it is a highly electrochemically active metal [1]. The primary attack seen in magnesium alloys is pitting attack, often initiating at iron-based intermetallic particles. However the exact morphology of the corrosion depends on the environment[2], [3]. The morphology of the corrosion damage will decide the level of reduction of the fatigue strength.

The morphology of the corrosion damage on AZ91 was investigated under various environments with and without chloride ions. The damaged surfaces were observed using several techniques including SEM, optical microscopy, in situ observations and replica techniques. The morphology of the corrosion damage was frequently observed to contain a series of filaments (Figure 1).

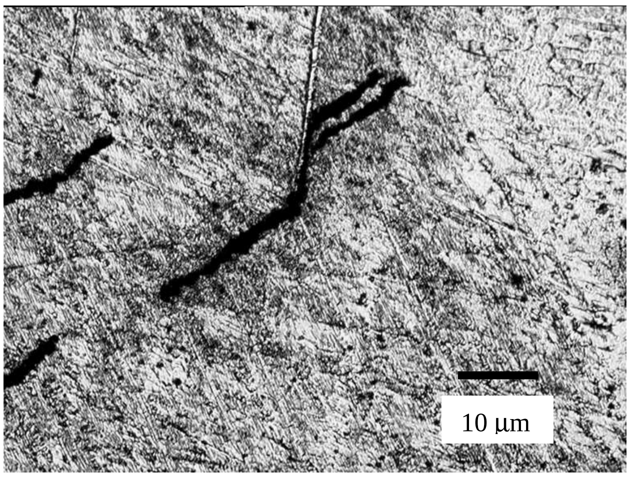

**Figure 1) Corrosion filaments seen in High Purity Magnesium at 75 mV above OCP in 0.1 M NaCl.**

The filaments were more closely investigated. They were produced in pure magnesium as well as AZ91. In-situ observation, ESEM, and SEM showed that the filament was covered by a film of corrosion products.

It is postulated that the filaments exist due to a delicate balance between the rate of the anodic dissolution and the production of the film, in a process similar to that which produces tunnel etch pits in aluminium[4].

One of the factors important to the existence of these filaments is the production of a film of corrosion products As the corrosion of magnesium raises the pH of the solution generally, the film was considered to be equivalent to that film that forms on magnesium at high pH. The production of films on magnesium at high pH was therefore studied with particular reference to the effect of various additions to the solution on those. The additions used included chloride, acetate, citrate and fluoride ions. It was observed that chloride ions caused local breakdown of the film at low concentrations, acetate had little effect, citrate ions attacked the film and fluoride ions strengthened the film. Figure 2 shows the effect of citrate additions on a well-established film under potentiostatic control. Each addition of sodium citrate is matched by an increase in current density, which indicates that the film has been thinned through the formation of citrate complexes with the film.

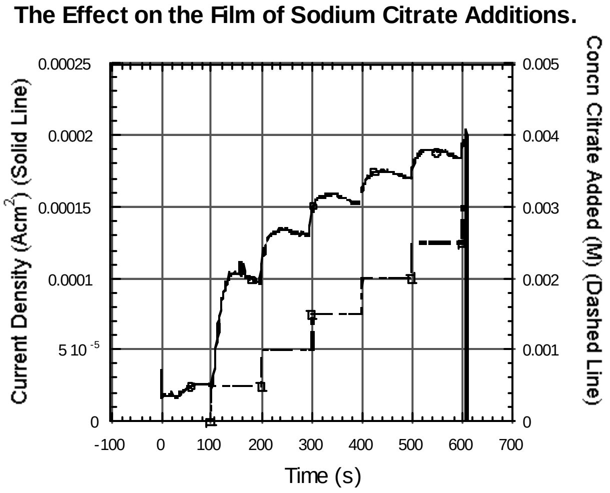

**Figure 2) The effect of sodium citrate additions on the film.**

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