

The University
of Manchester



**THE INFLUENCE OF HOT FORMING-QUENCHING (HFQ) ON
THE MICROSTRUCTURE AND CORROSION PERFORMANCE
OF AZ31 MAGNESIUM ALLOYS**

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Abstract

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The Influence of Hot Forming-Quenching (HFQ) on Microstructure and Corrosion Performance of AZ31 Magnesium Alloys

The hot forming-quenching (HFQ) process has introduced grains and subgrain growth, accompanied with modification of the intermetallic particle distribution in AZ31 magnesium alloys. Each region of the HFQ component represents significant grain structure variation and surface conditions that contributed to the corrosion susceptibility. The homogeneous grain structure significantly ruled the corrosion propagation features by filiform-like corrosion. Immersion of AZ31 alloys in 3.5 wt.% NaCl indicated higher corrosion rate of HFQ TRC (corrosion rate: 10.129 mm/year), a factor of 10 times, higher than the rolled alloy (corrosion rate: 0.853 mm/year) and a factor of 2 times, higher than the corrosion rate of MCTRC alloy (corrosion rate: 5.956 mm/year). Much lower corrosion rate was indicated in the as-cast TRC and MCTRC alloys, compared to the alloys after HFQ process that revealed the contribution of network or continuous distribution of β -Mg₁₇Al₁₂ phase particles to reduce the corrosion driven in chloride solution. In contrast, discontinuous distribution of cathodic β -Mg₁₇Al₁₂ phase particles increases the corrosion rate of HFQ TRC alloy by promoting the cathodic reaction and intense filament propagation resembling the coarse interdendritic and grain boundaries attack. The presence of high population densities of cathodic Al₆Mn₅ particles in HFQ rolled AZ31B-H24 alloy significantly reduced the corrosion driven for intense corrosion attack on the rolled alloy. The surface preparation by mechanical grinding process induced MgO and Zn-enrichment layer, accompanied with near surface deformed layer that consisted of nanograins in the range size of 40 to 250 nm. The grinding process refined the surface by removing the cutting damage and marks that formed during the thermomechanical process and led to stable potential of the HFQ AZ31 alloys, in the range of -1.59 to -1.57 V, during open circuit potential (OCP) measurement. The surface regularity with grinding path causing the filament to propagate following the grinding direction. The as-received surface contained many cutting damages and deep scratch marks from the rolling and casting processes that could introduce many corrosion initiation sites. The absence of the grinding direction on the as-received surface could control intense corrosion susceptibility, due to the non-linear filament propagation. The surface irregularity on chromic acid cleaned surface of HFQ rolled AZ31B-H24 alloy also contributed to low corrosion potential of the rolled alloy during OCP and potentiodynamic polarization measurement.

Declaration

No portion of the work referred to in the thesis has been submitted in support of an application for another degree or qualification of this or any other university or other institute of learning.

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