Elemental dissolution and hydrogen evolution during the corrosion and surface treatment of Magnesium

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Abstract: A novel AESEC-gravimetric system was developed, which allows for the simultaneous measurement of elemental dissolution, hydrogen evolution, and electron exchange. The degradation mechanisms of Mg alloys in various aqueous environments were investigated. In chloride (Cl^-) solution, both Mg dissolution and hydrogen evolution were observed in the anodic region. The anodic charge correlated with Mg^{2+} dissolution while hydrogen evolution was independent and led to insoluble Mg(II). Increased iron (Fe) impurity in Mg alloys promoted hydrogen evolution. In fluoride (F^-) solution, F^- helps to passive the Mg surface, suppressing both the Mg dissolution and hydrogen evolution in the anodic reaction. However, the passivity was broken by a clearly defined breakdown or pitting potential in the presence of Cl^- ions and correlation to the Cl^- concentration. In nitrate (NO^{3-}) solution, NO^{3-} ions replace the predominant cathodic reaction from water reduction to NO^{3-} reduction, resulting in significantly low gas evolution. The reduction of NO^{3-} produces OH^- in the solution, increasing the interfacial pH and forming oxidate or hydroxide to protect Mg.

Keywords: Elemental dissolution, hydrogen evolution, degradation, Magnesium