

Corrosion studies of magnesium, aluminum and zinc in citrate containing electrolytes

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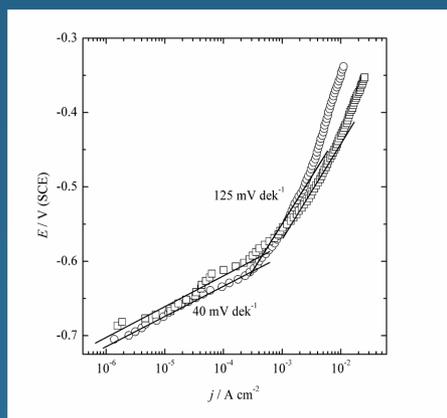
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Electrochemical power sources consisted of electroconducting polymers combined to electronegative metals and aqueous based electrolytes are likely to accomplish most of the three E criteria (*Energy, Economics and Environment*) elaborated as the determining factors of an electrochemical power system success. In such systems electroconducting polymers, mainly polyaniline (PANI) due to their ability of reversible oxidation (doping)/reduction (dedoping) could be used as cathodic materials, while owing to relatively low discharge potentials, it is necessary to use electronegative metals such as: magnesium, aluminum and zinc as anodic materials.

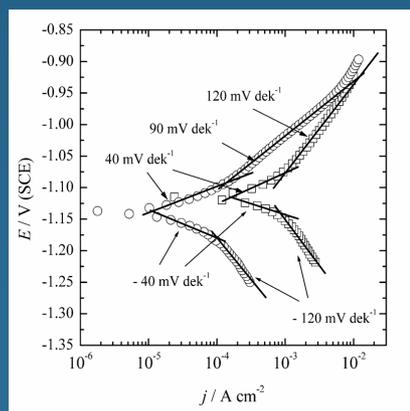
RESULTS

TABLE1. Corrosion potential and the mean value of the corrosion current density of Mg, Al and Zn in 0.2 mol dm⁻³ NH₄Cl (chl.) and in 0.1 mol dm⁻³ NH₄Cl + 0.1 mol dm⁻³ Na-citrate (chl./cit.)

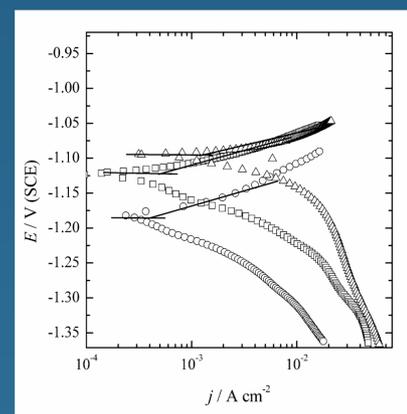
metal	$E_{\text{corr}} / \text{V (SCE)}$		$E_{\text{corr}} / \text{V (SHE)}$		$j_{\text{corr}} / \text{A cm}^{-2}$	
	chl.	chl./cit.	chl.	chl./cit.	chl.	chl./cit.
Mg	-2.130	-1.965	-1.889	-1.724	$1.35 \cdot 10^{-2}$	$1.05 \cdot 10^{-2}$
Al	-0.705	-0.688	-0.464	-0.447	$1.10 \cdot 10^{-6}$	$1.19 \cdot 10^{-6}$
Zn	-1.138	-1.116	-0.897	-0.875	$1.02 \cdot 10^{-5}$	$9.27 \cdot 10^{-5}$



Anodic polarization curve (1 mV s^{-1}) of aluminum in: (○) $0.2 \text{ mol dm}^{-3} \text{ NH}_4\text{Cl}$ and (□) $0.1 \text{ mol dm}^{-3} \text{ NH}_4\text{Cl} + 0.1 \text{ mol dm}^{-3} \text{ Na-citrate}$.



Anodic and cathodic polarization curves (1 mV s^{-1}) of zinc in: (□) $0.2 \text{ mol dm}^{-3} \text{ NH}_4\text{Cl}$ and (○) $0.1 \text{ mol dm}^{-3} \text{ NH}_4\text{Cl} + 0.1 \text{ mol dm}^{-3} \text{ Na-citrate}$.



Anodic and cathodic polarization curves (1 mV s^{-1}) of zinc in $0.3 \text{ mol dm}^{-3} \text{ NH}_4\text{Cl} + 0.8 \text{ mol dm}^{-3} \text{ Na-citrate}$ with addition of: (○) 0.1 ; (△) 0.3 and (□) $0.5 \text{ mol dm}^{-3} \text{ ZnCl}_2$.

It could be concluded that magnesium, aluminum and zinc were liable to corrosion in chloride and chloride/citrate electrolytes investigated electrolytes. Based on the values of the corrosion potential of magnesium of -1.889 V (SHE) in chloride and -1.724 V (SHE) in chloride/citrate electrolyte, corrosion process of magnesium in chloride and chloride/citrate solutions could be explained by anodic dissolution of magnesium and cathodic hydrogen evolution. Due to very low corrosion potential, magnesium might be considered as potentially good anodic material for activated primary electrochemical power sources.

Aluminum, comparing to magnesium and zinc, had lowest values of the corrosion current density of around $1 \mu\text{A cm}^{-2}$ and highest value of the corrosion potential of around -0.45 V (SHE) in both chloride and chloride/citrate solutions. It could be concluded that aluminum was in its passive state (Al_2O_3) at corrosion potential. Owing to the relatively high value of the corrosion potential, cathodic reaction could be oxygen evolution reaction. According to the value of the corrosion potential in investigated electrolytes, aluminum is not challengeable anodic material for primary electrochemical power source.

Corrosion potential of zinc in both chloride and chloride/citrate electrolyte were similar $\sim -0.88 \text{ V (SHE)}$, corrosion current density in chloride/citrate electrolyte was for almost one order of magnitude greater than in citrate electrolyte and it could be probably connected to influence of citrate ions on mechanism of zinc dissolution. It could be concluded that zinc was between stable metallic state and corrosion with formation of Zn^{2+} . For current densities of practical interest, potential of the zinc electrodes were around -1.05 and 1.0 V (SCE) , meaning that zinc could be considered as anodic material in primary electrochemical power sources based on PANI cathode. It was also concluded that zinc could be considered as anodic material in secondary electrochemical power sources, since in zinc containing electrolyte zinc deposition and dissolution was dominant reaction.

Acknowledgment

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