Electrodeposition of Niobium on Magnesium using Green Ionic Liquids

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In recent years magnesium (Mg) and its alloys are being increasingly investigated as alternatives to iron and aluminum to reduce the weight of structural materials in automotive applications. Magnesium is 36% lighter per unit volume than aluminum and 78% lighter than iron. When alloyed, magnesium has the highest strength to weight ratio of all the structural metals [1]. Magnesium also has high thermal conductivity, high dimensional stability, good electromagnetic shielding characteristics, high damping characteristics, good machinability and is easily recycled [1]. These properties make magnesium a highly desirable material for its potential automotive applications.

Several drawbacks have limited the growth of magnesium in automobiles. One of the most important is a relatively poor corrosion resistance [2]. Magnesium has a high chemical affinity and reacts with atmospheric oxygen and water resulting in the formation of magnesium hydroxide. Magnesium hydroxide tends to react with the environment and transform to carbonates of magnesium. These salts formed on the surface destroy the passive oxide layer leading to an acceleration of general corrosion. Magnesium corrodes even in moist air and in distilled water. The effect of aqueous solution on magnesium varies considerably depending on the nature of the solute. Magnesium is resistant to attack by alkalis but is attacked by most acids [3].

Coatings can protect magnesium and its alloys by providing a barrier between the metal and its environment. Electrochemical plating is a process by which a substrate is coated with a metal that has the desired properties necessary for the specific application. Challenges associated with this technology are in the use of toxic chemicals such as chromium, cyanide, fluoride and corrosive acid based pretreatment and bath solutions [4]. Magnesium reacts aggressively with most acids and dissolves in acid media which necessitates the avoidance of acid based electrolyte solutions. Hence there is a need to develop nontoxic acid free electrolytes for elctrodeposition on magnesium alloys.

In this paper we demonstrate the electrodeposition of niobium on magnesium using an environment friendly green ionic liquid. Niobium is a soft rare transition metal used in the production of high grade steel. It is corrosion resistant and exhibits superconductivity properties. Niobium finds several automotive applications in its use as an alloying agent to develop high strength steel grades [5].

Mg AZ31 samples were cleaned and used for electrodeposition. The electrostatic deposition was carried out in a controlled electrochemical cell with Mg as the cathode, niobium as anode and a proprietary developed ionic liquid as the electrolyte. The electrodeposition was carried out at 6 volts for 20 min. After termination of electrodeposition the Mg sample was rinsed in distilled water and ultrasonicated for five minutes to remove any adhering niobium and dried in air. The coated samples were characterized using scanning electron microscopy (SEM) to determine the surface topography and SEM-energy-dispersive X-ray spectroscopy (SEM-EDX) to determine the surface elemental composition.

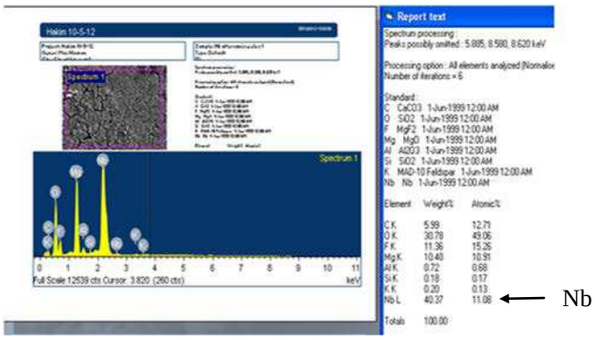

Figure 1: SEM-EDX analysis of niobium coated magnesium samples

Figure 2: SEM image of niobium coated magnesium samples

Figure 1 shows the SEM and EDX analysis of the magnesium surface coated with niobium. EDX analysis confirmed the presence of Nb on the surface of coated Mg samples (Figure 1). The visually observed coating on the surface of the Mg was analyzed using SEM (Figure 2). The surface of the coated Mg with Nb was fairly uniform however presence of surface irregularities including surface cracks were seen. The optimization of elctrodeposition parameters is currently in progress to develop a crack free coating. However the results of our study confirm the electrodeposition of Nb on magnesium.

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