Non-Chromate Conversion Coatings for Magnesium Alloys

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Problem Statement

Magnesium alloys are strong and lightweight making them ideal for use in the automotive and aerospace industries. Unfortunately, magnesium alloys suffer from a relatively high corrosion rate and require some form of surface treatment prior to painting. The most common treatments in use today are conversion coatings which contain chromium compounds. The most effective films contain chromium VI, a known carcinogen and highly toxic material.

Chromates have several advantages that lead to their widespread use:

- they are simple formulations that are easy to apply and effective on numerous alloys;
- they generally do not cause metal loss or attack most ferrous or plated surfaces;
- residual chromium solutions remaining in the interstitial spaces are not known to cause hydrogen embrittlement or other harmful effects.
- They persist on the surface to promote the formation of stable magnesium oxide barrier films when damaged.

Historically, chromates were selected for their effectiveness. However, they are far from safe. They are persist in nature and persistent toxins cause contamination of ground waters and are harmful to the user's health. Thus, the elimination of chromium compounds has become a national priority.

Technology Description

The proposed research is centered on duplicating the properties and performance of chromate conversion coatings on magnesium alloys without the use of toxic or carcinogenic materials. The nature of magnesium can be exploited by the use of a variety of compounds that promote the formation of stable magnesium oxide barrier films at damage sites. Most materials do not form stable films suitable for painting, do not persist on the coated surface, are often too soluble or do not form insoluble precipitates when reduced.

Chromates initially form hydrated gel films that are known to be effectively dyed using reactive acid dyes. It has been speculated that chromate films which mature to the crystalline state would hold excess chromium. With this in mind, the replacement technology will stem from one of two approaches:

• Film Forming: Determine a low toxicity chemistry that forms a persistent film by direct contact to the alloy.

• Film Dying: Form a hydrated magnesium gel film in a non-toxic chemistry. Determine a low toxicity reactive chemistry in an inhibited acid form using this to dye and fix the gel film making a persistent coating of limited solubility.

The materials under consideration are selected from the transition and alkali metals with particular attention to the quality and quantity of toxicological data available.

Expected Results

The expected result of this project is to produce viable coatings of both types. The feasibility of producing coatings that perform as well or better than chromate must be shown. The cost and benefit of the replacement technology must also be shown. The use of inhibited acidic formulas and appropriate adjuncts such as surfactants should prove favorable for paint adhesion.

Some of the coatings formed are expected to mature to crystalline form much the same as the chromate films.

Success in the automotive industry often hinges on mere pennies. To be commercially successful, a reduction in cost is desirable. Cost reduction can be gained through lower material expense, reductions in energy use, reduced water use, reduced wastewater treatment, reporting and handling charges. Reductions in cost can also come with increased performance of the coating system.

The expected result is to match the performance of chromate systems but to show a reduction in cost through reduced waste costs by eliminating hazardous waste charges.

Potential Environmental Benefits

It cannot be overstated. The impact of eliminating chromates will not only benefit the health of workers but also the environment. The spirit of the research is to eliminate chrome from not only the coating tank but also from the cleaning and pretreatment that is often required to make chromate conversion coatings practical. The proposal is based in part on an in depth knowledge of very low toxicity cleaning and pretreatment methods used for the Tagnite Coating System.

The most commonly used magnesium coatings are chromate conversion coatings. The toxicity and environmental aspects of chromates are well documented. The primary impact of this project would be the elimination of chromates from metal finishing industries which will allow automotive manufacturers to meet environmental mandates while allowing for the continued growth of magnesium. Expanded use of magnesium would result in additional fuel savings and/or lower emissions.

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