METAL DEPOSITION FROM IONIC LIQUIDS FOR SURFACE COATINGS

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Abstract

Electrodeposition of metals, with an emphasis on Aluminium, from ionic liquids is described. The influence of additives, cation-anion combinations and deposition conditions on the deposition speed, morphology and composition is discussed. A brief life cycle analysis of the electrolyte is also included.

Introduction

The reduction of aluminum from organic solutions of Al-halides was shown by *Plotnikov* for the first time in 1899.[1] Various investigations on electrolyte variations for Al plating have been already described, some of them leading to galvanic depositions of purities beyond 99.99%[2] but still some problems persist such as self-ignition of the organo-Al compounds, the flammability of the organic electrolytes and the high cost of the Al-source. In addition, other types of Al-plating electrolytes have been developed, but those drawbacks as well as low film purity and complicated process handling have not been completely resolved. This is now possible with the help of ionic liquids.

Discussion

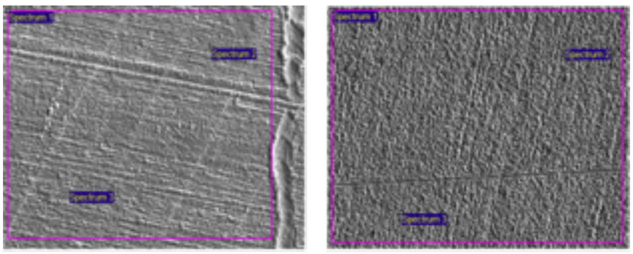
Ionic liquids (ILs) are ionic compounds with melting points below 100°C, which have a range of useful properties, among which non-flammability, thermal and chemical stability and very low vapor pressure. Because of those in recent years, the focus was placed more and more on them as potential electrolytes for the deposition of non-noble metals. Further some of them provide also a wide electrochemical window, which is an important feature for the deposition.[3]

A major benefit of ionic liquids is the relative high solubility of metal salts in them. By varying the cation-anion combination or even by slight changes in the side chain

of the cation and/or anion the properties of the ionic liquids can be fine-tuned to the requested application.
Although many metals and metal alloys have been deposited from ionic liquids[4], including Scandium[5] we will concentrate in our presentation on aluminium, because of its broad availability and wide use in aerospace industry.

Figure 1: Aluminium plated toy car.

Current results of Al electroplating (Figure 1) will be shown in our presentation. They have been done at ambient temperature in different electrolytes, where the ionic liquid, the $AlCl_3$ concentration and the additives are varied. So it is possible to deposit Al films of different thickness on substrates with different shapes, composition and morphology (Figure 2). Depending on the desired application the coating can be shiny or matted.



Additive A

Element	%W
O	16.8
Al	70.9
Cl	3.8
C	8.5

Additive B

Element	%W
O	1.7
Al	89.9
Cl	0.0
C	8.4

Figure 2: Structure and composition of the deposit depending on the additives

The only limitation of the process is that because of the relatively high viscosity of the electrolyte, leading to lower current densities, which unlike deposition from a melt, do

not allow bulk deposition, but are nevertheless a fast, efficient and versatile method for surface treatment, coating and corrosion protection.
Furthermore, a Life Cycle Assessment of the galvanic Al-deposition by using ILs is also discussed.

References

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