Regular Paper

Quaternary Ammonium Salt Additives for High TiO_2 Particle Content in Electrodeposited Zn-TiO_2 Composites

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Abstract

Quaternary ammonium salts of four different chemical structures, used as additives in electrodeposition baths, were compared in order to obtain a higher TiO_2 particle content in electrodeposited Zn-TiO_2 composites. Electrodeposition baths containing 0.1 mol/dm^3 $ZnSO_4 \cdot 7H_2O$, 0.2 mol/dm^3 $MgSO_4$, 0.15 mol/dm^3 H_3BO_3, and 10g/dm^3 TiO_2 powder were prepared. In addition, benzylcetyldimethylammonium chloride (BCDAC), benzyldimethyltetradecylammonium chloride dehydrate, hexadecylpyridinium chloride monohydrate, and benzethonium chloride were introduced to the baths as additives. The titanium content ratio in the Zn-TiO_2 electrodeposited from a bath with 2.0 g/ dm^3 BCDAC additives reached 59.9 atomic% at an electrodeposition current density of 500 A/m^2. Furthermore, a higher TiO_2 content in the Zn-TiO_2 composites caused a greater dendritic aggregation of TiO_2 particles on the surface. These findings suggest that BCDAC containing a benzene ring and a longer group provides a higher TiO_2 particle content in the Zn-TiO_2 composites, and more dendritic structure.

Keywords: Electrodeposition, Zn-TiO_2, Quaternary ammonium salts, BCDAC

1. Introduction

Zn-TiO_2 composites are expected to improve corrosion resistance [1], furthermore an attractive coating as a photocatalytic material [2]. Several researchers have investigated controlling the co-deposited TiO_2 particle content using various methods [3-6]. Camargo et al. reported the influence of ultrasound on the electrodeposition of Zn-TiO_2 composites in which the TiO_2 particle content was 0.53–0.78 wt% [5]. Achieving a TiO_2 particle content of 2.26 to 5.58 wt% depended on the bath temperature [4]. Also, the hardness of Zn-TiO_2 coatings increased with increasing TiO_2 particles wt% in the coatings in the region of 2.26–5.58 wt% [4]. The photocatalysis is likely to be improved by increasing TiO_2 content, because the increase in TiO_2 content gives the increase in a reaction field and an adsorption activity site. Furthermore, a $ZnCl_2$-based electrodeposition bath led to a higher TiO_2 particle content in the Zn-TiO_2 composites [5]. In any case, the TiO_2 content needs to be controlled and optimized for the application.

The behavior of particles in the composites is affected by different parameters of the electrodeposition conditions [7]. The introduction of surfactants as additives prevents particles from aggregating in electrolyte solutions, suppress hydrogen generation on cathodes during electrodeposition, and change the surface potential of particles [6]. Surfactants have been used for electrodeposited Ni-Al_2O_3 [8,9], Ni-WC [10], and Ni-SiC [6,11] composites. Cationic surfactants influence the amount of

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