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Structural properties and microhardness performance of induced composite coatings filled with Cocos nucifera-tin functionalized oxide

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Abstract

The potential of Cocos nucifera (CJ)-tin functionalized oxide prepared in sulphate bath on zinc based electrolyte was examined in an attempt to improve the structural behaviour and examined the microhardness characteristics of the developed coatings. The microstructural evolution was checked using scanning electron microscope attached with energy dispersive spectrometer (SEM-EDS). The microhardness properties of the composites were investigated by means of high impact diamond base microhardness indenter with an average of 5 relative intervals. The results show a film containing Zn-SnO2-CJ deposits on the mild steel resulting into strong crystal structure. The effect of Cocos nucifera-tin functionalized oxide as complex agent was noticed to improve the structural build up, strong compactness and decrease porosity.

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Keywords: Crystals; Coatings; Microhardness; Coconut juice (CJ)

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1 INTRODUCTION

The massive use of low carbon steel in structural and aesthetic applications is due to its availability, low cost and physical properties [1-3]. This property has made mild steel versatile among metallic alloys in service [4]. The major challenge has been severe structural degradation of mild steel as a result of metal interactions between external environments in term of wear plastic deterioration, low hardness characteristics and poor corrosion resistance [5-6].

In other to salvage these menaces, several protective prevention methods have been engaged over decade by researcher to extent the service life of mild steel [7]. Electrodeposition is a traditional method but ever reliable deposition concept with tendency of impacting compactness, evenness and provides thin film on metal [8-9]. Moreso, with deposition technique, composite coatings are produced by dispersing nanosized particles in a coating matrix for better structural and mechanical performance [10]. Composite particle such as ZrO2, MgO, SiO2 and TiO2 have been co-deposited to produce functional properties [11-13]. In coating technology especially, the electrolytic deposition, the incorporation content, particles and process variable are important factor that determine the efficient of electrolyte and the kind of coating produced [14-15].

Study had also showed that extractive juice as additive agent influences structural properties which also impact possible mechanical potential on coatings [16]. In an attempt to better the morphology of the electrodeposited coatings and resist agglomeration a newly developed multifunction particle with eco-friendly fluid instead of adding multiple solid particle distribution is envisage [17, 18]. The technique combines traditional technique of electrodeposition with sol gel method in form of juice to obtain solid uniform metal composite coatings [19].

In this present study, attempts were made to produce Zn-SnO2 composite coatings using Cocos nucifera-tin functionalized oxide enhanced Zn base electrolyte. The microstructure and microhardness properties of the Zn-SnO2-CJ embedded coating were studied and compared with Zn-SnO2 alloy coating.

2 EXPERIMENTAL METHOD

2.1 Preparation of Substrate

Mild steel specimens of (40 mm x 20 mm x 1 mm) sheet were used as substrate and zinc sheets (30 mm x 20 mm x 1 mm) were prepared as anodes. The working mild steel specimens have a weight composition as described in Table 1. The cathode was mild steel coupons and anode was pure zinc (99.99%). The mild steel specimens were polished mechanically using different grades of emery paper in the order of 60, 120, 400, 800 and 1,600 µm to erase any existing impurities and marks. The samples are further degreased and immediately water washed.

Table 1: Nominal chemical composition (wt. %) of mild steel substrate

Element	C	Mn	Si	P	S	Al	Ni	Fe
(%) Composition	0.15	0.45	0.18	0.01	0.031	0.005	0.008	Balance

2.2 Formation of Deposited Coating

The mild steel substrate earlier prepared was activated by dipping into 10% HCl solution for 5 seconds followed by rinsing in distilled water. Analytical grade chemicals and distilled water were used to prepare the plating solution at room temperature. Prior to plating, the coconut juice was added to the prepared Zn-SnO2 alloy particles electrolytic solution as indicated in table 2. The formulations were then heated to 40ºC to easy admix and dissolution of any agglomerate in the bath solution. The bath produced is concurrently stirred as heating trend lasted for 3hours before plating.