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To Develop the Electroless NiP-ZnO Coating on Glass Substrate by Electroless Technique

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Abstract
The aim of present study is to develop electroless coatings of Ni-P and composite Ni-P-ZnO by co-deposition process on transparent non-conductive soda lime glass substrates. Ni-P-ZnO coatings were prepared using conventional route i.e., ZnO particles of ~ 20 µm with average diameter were added to the bath (90^0C, pH ~9.0) and kept in suspension by stirring. Uniform and greyish bright coatings were observed. The coatings were heat treated at 400 °C for 1h in argon atmosphere to attain crystalline nature of coating. The as-synthesized Ni-P and composite Ni-P-ZnO coatings were characterized by FESEM/EDAX.

Keywords: Electroless coating (EL), Ni-P-ZnO electroless composite coatings (EL).

1. Introduction

Electroless coating is an autoatalytic process in which reduction of the metallic ions, and subsequent deposition of a film on certain catalytically active substrate surface takes place using a controlled chemical reaction. Nickel–phosphorous (Ni-P) coating is widely used as an electroless coating in different industries because of its inherent uniformity, hardenability, uniform coating thickness and corrosion and wear resistances [1]. Incorporation of submicron-sized and micron-sized second phase particles (X) (X = SiC, Fe_3O_4, B_4C, PTFE etc.,) into the Ni–P matrix has attracted much attention in order to improve the surface properties e.g., Ni-P-SiC (50 µm thick) show high corrosion and abrasion resistance, Ni-P-Fe_3O_4 is resistant to high temperature corrosion, Ni-P-B_4C has magnetic field application, Ni-P-PTFE show dry lubricity etc., [3-6]. Apart from this, other common nano-particles used in EL coatings are SiO_2, ZrO_2, TiO_2, Al_2O_3, ZnO, etc. ZnO due to its characteristic structure possesses unique chemical, biological and semi-conducting properties. Because of its non-toxic nature and ability to block UV radiation, it has found vast applications in cosmetics, textile and in many coatings systems. The preparation and deposit of Ni-P-X composite coatings through autocatalytic reduction has provided a novel and efficient technique for application in the field of surface coating and surface finishing on metallic and non-metallic substrates [7-10].

The aim of the present work was to develop electroless NiP and composite NiP-ZnO coating by co-deposition process on glass substrates. The ‘as synthesized’ Ni-P and composite Ni-P-ZnO coatings were characterized by FESEM/EDAX and X-ray mapping by EDAX.

2. Materials and method

2.1 Surface preparation

Glass substrates were firstly degreased with acetone and then etched for 2 minutes in hydrofluoric acid (HF), after etched rinsing with deionized water, the substrates were activated by dipping in an aqueous acidic solution of palladium chloride to initiate the reaction at catalytic sites.

2.2 Preparation of Ni-P and Ni-P-ZnO composite coatings

Ni-P-ZnO composite coatings were developed on flat surface of glass substrate (20×20 mm^2 and 0.5 mm thick) by conventional method (i.e., the second phase particles are introduced from outside to the reaction EL bath). To develop Ni-P-ZnO composite coating the second phase ZnO particles (as-received of size ~ 20 μm) were added to the EL bath. EL bath consists of $NiSO_4.6H_2O$ (6.25g), NH_4SO_4 (12g), $C_6H_5Na_3O_7.2H_2O$ (22.5g), $NaH_2PO_2.H_2O$ (5g), ZnO (2.5g), temperature of bath was kept at 90 ±2 °C with pH value of 9.0 ±0.2, pH is controlled by pH controlling reagent (i.e., ammonia buffer solutions). Activated substrate followed by immersing in an electroless nickel plating solution. For comparison, plain Ni-P deposit without ZnO particles was also prepared and surface morphology of coatings are study by FESEM-EDAX (QUANTA 200 F, FEI Netherlands)

3. Results and Discussion

3.1 FE-SEM Analysis of NiP-ZnO coating on Glass

FE-SEM images along with EDAX are shown in Figs.1 (a-h). The ZnO powder used for the present study is of irregular shape which is observed by FESEM-EDAX micrographs Fig.1 (a-b). FESEM & EDAX of plain glass (i.e., without coating, (Fig. 1c, and d)), NiP (Fig. 1e, and f) and NiP-ZnO composite coating (Fig. 1g, and h) are presented in Fig. 1. From the FESEM micrographs it has been observed that on the glass substrate the NiP coating is developed with nodular globules, and the elemental percentage is in the stoichiometric ratio as observed by EDAX micrograph. Homogenized deposit covering the whole area has been observed by addition of ZnO particles in electroless bath which is clearly seen from the FESEM micrograph Fig.1 (g) and the incorporation of the ZnO particles into the matrix is also confirmed by the presence of ZnO peak in EDAX spectrum Fig.1 (h). The embedded ZnO grains into the amorphous matrix distinctly reduce the surface development of the composite NiP-ZnO layer, compared to plain electroless NiP coating.

3.2 EDAX Analysis of NiP-ZnO coating on Glass

In all three EDAX spectra Fig.1 (d, f & h) one silica peak is clearly observed corresponding to glass substrate. Spectra given in Fig. 1(f) confirm the presence of nickel and phosphorous with base material peak (i.e., silica). In EDAX spectrum (Fig. 1h) the peaks O(K), Zn(K) and Zn (L) observed along with Ni(K) and P(K) peaks indicate the presence of ZnO particles in the NiP-ZnO composite coating.

3.3 X-ray Analysis of NiP-ZnO coating on Glass

X-ray mapping results Fig. 2 (a-e) shows the scanning of separately distribution of particles i.e., Ni, P, Zn, O and NiP-ZnO in a typical NiP-ZnO coating matrix which provide the information regarding the distribution of the particles, these figure revels that the particles are distributed uniformly on the coated surface of the substrate.

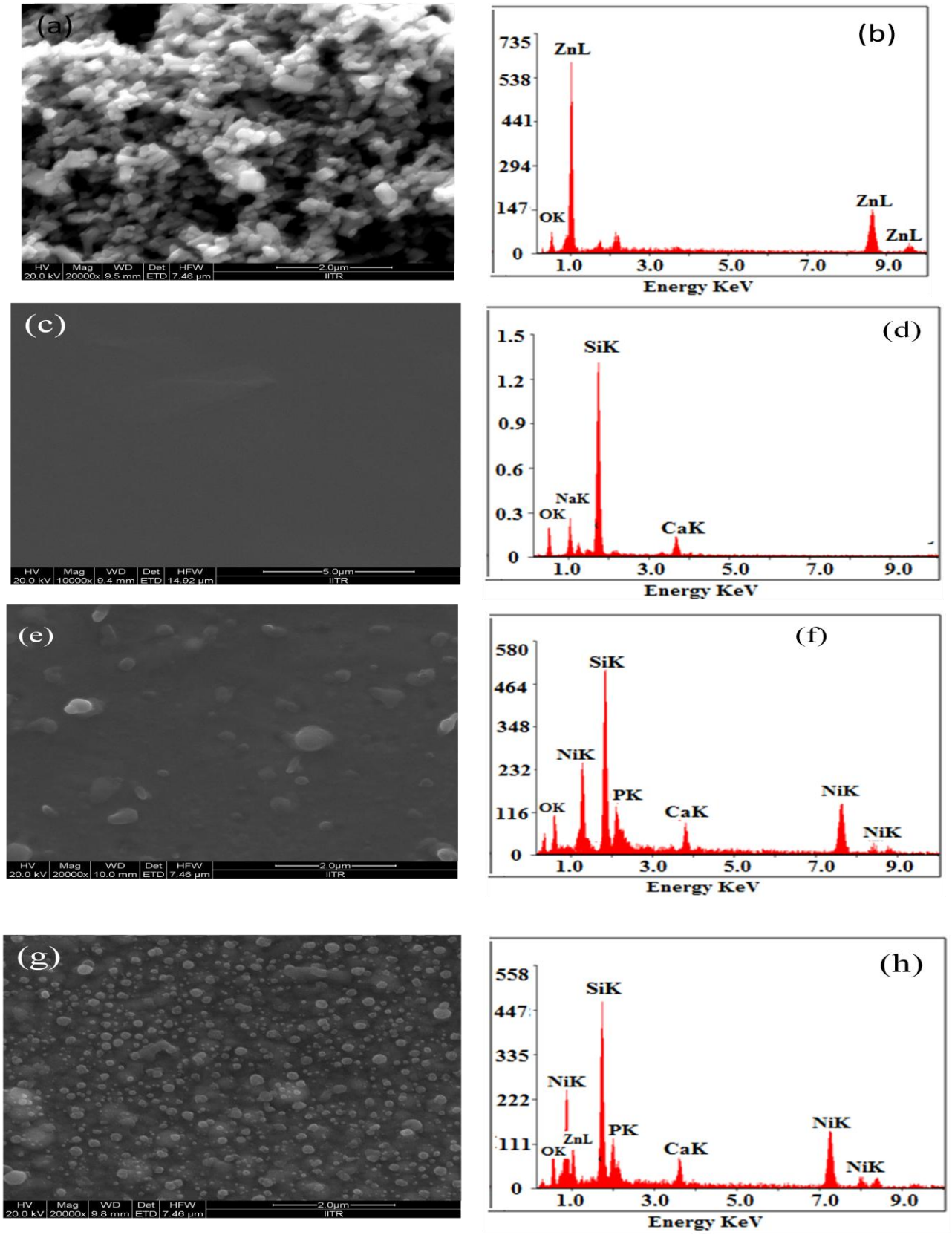

Figure 1: FESEM and EDAX micrographs of ZnO particles used (a, b); Plane glass substrate without coating (c, d); Ni-P (e, f) and Ni-P-ZnO coating on glass substrate and (g, h).

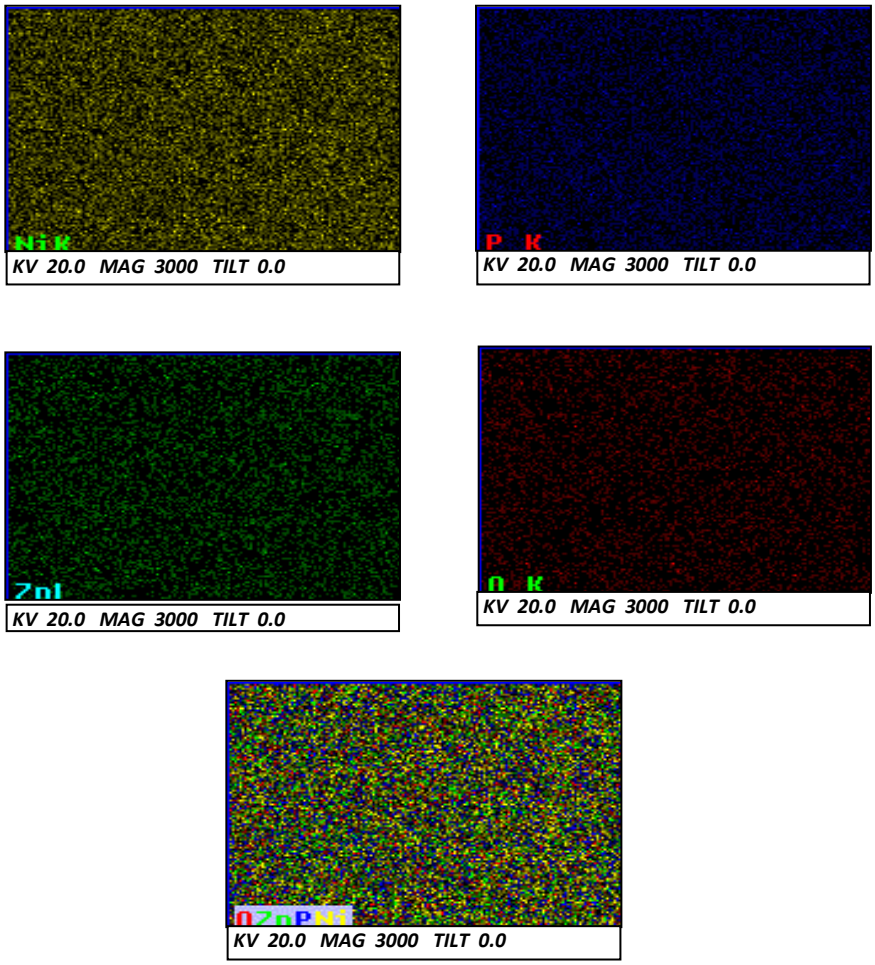

Figure 2. (a -e) X-Ray mapping of NiP-ZnO composite coating on glass substrate

Conclusions

Through the present study NiP-ZnO coatings are successfully developed on nonconductive glass substrate. The globule size of NiP reduced on addition of ZnO particles in NiP matrix. These coatings will be studied further for their magnetic response.

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