UNIFORMITY INVESTIGATION OF DEPOSITED NANOPARTICLES VIA PULSE DIRECT CURRENT (DC) IN ELECTROPHORETIC DEPOSITION (EPD)

RESEARCH MANAGEMENT INSTITUTE (RMI)
UNIVERSITI TEKNOLOGI MARA
40450 SHAH ALAM, SELANGOR
MALAYSIA

BY :

RABIATUL ADAWIYAH ABDOL AZIZ
NOOR FITRAH ABU BAKAR
MOHD NAZLI NAIM

JANUARY 2013

Contents

5. Report

5.1 Proposed Executive Summary

Nowadays, with increasing thrust on nanostructured materials, Electrophoretic Deposition (EPD) technique is being viewed with more interest for assembly of nanoparticles. It covers a wide range of applications such as photonic materials, high density magnetic data storage devices, microchip reactors and biosensors.

Obviously, the use of water/aqueous implies advantages such as a faster kinetics, in addition to important health, environmental, and cost benefits. However, it causes a number of problems in electrophoretic forming mainly related to electrochemical reaction in the electrodes when current is passed through, which seriously affects the efficiency of the process and the uniformity of the deposit.

Different sizes of standard nanoparticles i.e. polystyrene latex (PSL) particles will be diluted with milipore water into several concentration media and it will be sonicated . pH of the aqueous will be prepared in acid and alkaline media by adding HCl and NaOH respectively. Carbon and copper electrode will be submerged in the media. EPD with Direct Current (DC) voltage will be applied during the deposition process. The deposited particle will be weighed with balancer. For the case of pulse DC, different frequency of pulse cycle will be applied. The deposited particles will be analyzed using X-ray Diffraction (XRD). The morphology of the deposited naoparticles will be analyzed by using Scanning Electron Microscopy (SEM). Distribution of the deposited particle will be characterized iether by using EDS analyzer in SEM.

In this work, we propose to evaluate the uniformity of the deposited particles with EPD technique, pulse DC will be applied in the experiment with different frequency of pulse cycle.

5.2 Enhanced Executive Summary

Nowadays, with increasing thrust on nanostructured materials, Electrophoretic Deposition (EPD) technique is being viewed with more interest for assembly of nanoparticles. It covers a wide range of applications such as photonic materials, high density magnetic data storage devices, microchip reactors and biosensors.

Obviously, the use of water/aqueous implies advantages such as a faster kinetics, in addition to important health, environmental, and cost benefits. However, it causes a number of problems in electrophoretic forming mainly related to electrochemical reaction in the electrodes when current is passed through, which seriously affects the efficiency of the process and the uniformity of the deposit.

100nm polystyrene latex (PSL) particles were diluted with distilled water into several concentration media and it will be sonicated . pH of the aqueous will be prepared in acid and alkaline media by adding HCl and NaOH respectively. Carbon and copper electrode will be submerged in the media. EPD with Pulse Direct Current (DC) voltage will be applied during the deposition process. The morphology of the deposited PSL was analyzed by using Field Emission Scanning Electron Microscopy (FE-SEM). The amount of deposited particles was calculated from the FE-SEM images within the region of interest (ROI) of 5.13 mm x 3.73 mm.

In this work, we were investigated the performance of PSL particle deposition on stainless steel via pulse DC in EPD

5.3 Introduction

Electrophoretic deposition (EPD) is a coating technique that has advantages because of its simple apparatus, high rate of deposition, suitability for mass production and reliability of the process [1]. Compared to other advanced shaping techniques, EPD process is very versatile since it can be modified easily for a specific application.

EPD is conducted a aqueous or non aqueous system whereby electric field is applied as a force to move suspended particles around and deposited on the specific electrodes. The movement of the particles depends on the charge that the particles carried, for the device that consume power, anode act as positive electrode and cathode act as negative electrode, so, if the particles charge negatively, the particles will be deposited on anode, and the positively charged deposited on cathode.

In EPD process, a suitable suspension should be choosing which generally required: 1) particles with charged surface to ensure that the particles migrate with applied electric field, 2) particles are well dispersed, 3) containing free ions co-existing in suspension, 4) particles that have high adhesion ability [2].

Due to electrolysis and electroosmosis particularly for aqueous system, formations of bubbles on the electrode interrupt the deposition of suspended particle to the electrode [3]. To deposit a uniform layer of the suspended particles, pulse DC can be used during EPD to minimize the bubble formation at the electrode.

Although this technique is well-established, kinetic behavior of depositing the suspension on the electrodes still need a substantial study. In this study, deposition of polystyrene latex (PSL) suspension in acidic environment of aqueous system is demonstrated under pulse DC condition whereby the pH localization and bubble formation are quantified properly.