DEVELOPMENT OF HYDROPHILIC SiO_2/TiO_2 DOUBLE LAYERS COATING FOR AUTOMOTIVE GLASS APPLICATION BY LOW-COST DIP COATING METHOD

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

BY :

MUHAMMAD ZAHIRUDDIN RAMLI
NUR FADZEELAH ABU KASSIM
NURULHUDA AMRI

MARCH 2011

CONTENTS

Tarikh : 15 Mac 2011
No. Fail Projek : 600-RMI/ST/DANA 5/3/Dst (96/2009)

Penolong Naib Canselor (Penyelidikan)
Institut Pengurusan Penyelidikan
Universiti Teknologi MARA
40450 Shah Alam

Y. Bhg. Prof.,

LAPORAN AKHIR PENYELIDIKAN "DEVELOPMENT OF HYDROPHILIC SiO_2/TiO_2 DOUBLE LAYERS COATING FOR AUTOMOTIVE GLASS APPLICATION BY LOW-COST DIP COATING METHOD"

Merujuk kepada perkara di atas, bersama-sama ini disertakan 4 (empat) naskah Laporan Akhir Penyelidikan dan 1 (satu) CD bertajuk "Development of Hydrophilic SiO_2/TiO_2 Double Layers Coating for Automotive Glass Application by Low-Cost Dip Coating Method" oleh kumpulan penyelidik dari Fakulti Kejuruteraan Kimia, UiTM Pulau Pinang untuk makluman pihak tuan.

Sekian, terima kasih.

Yang benar,

MUHAMMAD ZAHIRUDDIN BIN RAMLI
Ketua
Projek Penyelidikan

5.1 PROPOSED EXECUTIVE SUMMARY

Photocatalytic mirror has many unique yet extremely practical features in automotive application by being the hydrophilic nature of the mirror. Hydrophilic equals to no water beading like in conventional mirror which also translates into absolutes clear vision during rain. This hydrophilic ability is achieved by coating the mirror with 2 layers, TiO_2 and SiO_2 layers. SiO_2 is a true hydrophilic outer layer that prevents water from forming beads but instead a consistent film so that optically-clear vision is possible. The inner TiO_2 layer absorbs solar rays and decomposes organic matter through the photocatalytic process resulting in continuous self-cleaning action. Thus, combination of this two layers work seamlessly to provide the best possible vision all year around under any weather conditions. Sol-gel method is used in coating formulation due to its reliability while dip coating method is employed during a coating stage due to its simplicity and cost effective. The expectations from the morphology studies such as Scanning Electron Micrograph (SEM) and Transmission Electron Mictrograph (TEM) are to reveal visually the surface structure of the prepared coating particularly in terms of its crystal pattern, crystal distribution within the structure and the tickness profile of the coating. X-ray Diffraction analysis also expected to justify the type of crystal formed, either anatase or amorphous. Due the the fact that the proposed coating farmulation will eventually been applied on the outer surface of an automotive glass, the performance characteristics such as reflectance and transmittance of the coating should be extensively studied. In order to ensure the safety aspects of this coating for automotive glass application particularly the driving visibility, the percentage of reflectance to be achieved should be as lowest as possible while transmittance percentage should be as highest as possible. For further study in this research field, hydrophilicity of the double layer coating should be the primary interest to enhance the feasibility and the special feature of the coating in automotive glass application.

5.2 ENHANCED EXECUTIVE SUMMARY

Unclear vision through the automotive glass is always occurring when accumulated water droplets create reflection and refraction of light especially on a rainy day. This is due to the conventional mirror surface is water resistant or repellent (hydrophobic). In this study, SiO_2/TiO_2 double layers of thin film coated on the glass plate had been prepared using inexpensive dip coating method to overcome this limitation. Morphology wise, the samples were characterized using X-Ray Diffraction (XRD), Fourier-Transform Infrared (FT-IR) analysis, Scanning Electron Microscopy (SEM) and BET Surface Area Analysis. Meanwhile, performance characterization of the samples were carried out via UV-Visible Spectroscopy and water contact angle analysis to determine the transmittance and hydrophilic properties, respectively. XRD

result revealed that the TiO_2 xerogel before calcination step was in amorphous phase, but changing into anatase phase after calcination was done. At 500°C, the PEG structured phases are converted to anatase phase, suggesting that the high calcination temperature increases the tendency of a complete crystal growth. As for SiO_2, almost the same pattern of IR spectra was obtained for sample that before and after calcination which correspond to SiO_2 network in the film. Visual morphology study by SEM justifies the reliability of the method used. A small-size of SiO_2 particles were distributed uniformly on the surface of the film while the TiO_2 particles form a relatively larger aggregates. As expected for the double layers film, SiO_2 particles aggregates which randomly distributed on the surface of TiO_2. The above trend was in line with BET surface area obtained for SiO_2 and TiO_2 xerogel powder. Furthermore, the heat treatment employed during the coating and curing process was perfectly achieved as proven by zero crack spot exist on the coating surface. Performance wise, the prepared coatings were also shown a promising result whereby the water contact angle analyses that served the hydrophilic and self-cleaning function of the coating revealed that SiO_2/TiO_2 double layer has demonstrates hydrophilicity property based on the 13.9° of angle achieved. Moreover, light transmittance characterization on the double layer coating sample shows a significantly high transmission percentage of 71% which is higher than what have been permitted by regulation from Malaysian Road Transport Department. Based on its inexpensive method as well as all the positive characteristics, it concludes the feasibility of this type of coating to be used in automotive industry in the near future.

5.3 INTRODUCTION

Coating technology has developed rapidly over the recent years in line with its wider applications particularly in automotive and construction sectors. Various types of coatings have been applied on the glass surface in order to achieve the desired features and properties such as solar control, privacy enhancement, defogging, anti-reflection, anti-static, anti-abrasion, self-cleaning, self-water repellent and electrical conductivity.

Recently, numerous studies have been conducted by the researchers all over the world in order to enhance the performance of the conventional automotive glass, specifically on the self-cleaning and water-repellency property. Unclear vision through automotive's mirror is always occurring when accumulated water droplets create reflection and refraction of light (i.e. distortion). It always happened especially when it is raining. This is due to the conventional glass and mirror surfaces are water resistant/water-repellent, i.e. hydrophobic that can cause the loss of visibility during driving. Therefore, it is necessary to find an effective way to change the hydrophobic