

CHAPTER I

INTRODUCTION

1.1 Motivation

Glass has shown a great promise in the field of building decoration due to its optical property which can be widely used for increasing in coming light in work place, motor vehicle and other applications [1]. However, the important problem of glass is its cleanliness because dust, organic substances in the air, fog, fouling, and raindrops easily contaminate it. In general, we can solve this problem by cleaning the glass frequently. Nevertheless, it is quite difficult to clean a tall building's windows. Scientists have been searching and come up with a self-cleaning glass by using photocatalyst for eliminating contamination.

Hydrophilic/hydrophobic property is one of the key features essential for self cleaning property, which is required for various applications, such as cleanness of glass windows of any tall buildings. There are many attempts in search of hydrophilicity, which is obtained by using polarized molecules or some photocatalysts, while hydrophobicity is acquired from organic compounds. Meanwhile, it has been found that polyelectrolyte compounds, which contain an organic chain and the other end of polarized molecules, could hold strongly on glass surface. The polarized end of polyelectrolyte compound has hydrophilic property which can break down water droplets to spread over the coated surface and help rinse away loose dirt. The hydrophilic property of the coated surface containing photocatalyst is triggered by the ultraviolet (UV) irradiation. The hydrophilicity can simply be evaluated by mean of water contact angle measurement. With the contact angle less than 5° , the coated surface is recognized as superhydrophilic characteristics [1-9]. If water droplet contact angle is greater than 150° , the coated surface is classified as superhydrophobic one. The wettability is one of the important properties of solid surface from aspects of both fundamental research and practical applications. It is mainly controlled by the surface energy and the surface roughness. The surface

roughness is found to affect the hydrophilic property of the surface, while the hydrophobic surface becomes more hydrophobic. Among various semiconductor oxide materials, zinc oxide (ZnO) is a wide band gap (3.37eV) [10-15], which can be chemically activated by UV light to exhibit hydrophilicity. Regarding to previous work, ZnO thin film was prepared by sol-gel dip coating method using zinc acetate as a precursor and then photoinduced hydrophilic property of the coated glass substrate was investigated [2]. It was reported that the ZnO thin films prepared using 0.10 M zinc acetate and ethanol as the solvent with withdrawal speed of 3.0 cm/min at calcination temperature of 500°C, its transmittance above 90% in visible region. The film exhibits highly hydrophilic property because of its the water contact angle of 5 degree after 30 min UV irradiation.

Recently, the semiconductive nanoparticles embedded in multilayer polymer film was studied by precipitation of ZnO into Poly(diallyldimethylammonium chloride) (PDDA) and poly(styrenesulfonate) sodium salt (PSS) with layer-by-layer self-assembly technique[10]. The results reveal that the repetitive adsorption of zinc nitrate and subsequent precipitation in ammonium hydroxide provided an effective method to fabricate multilayer film containing ZnO nanoparticle. The morphology of ZnO nanoparticles were controlled by the precipitation reaction cycles. Meanwhile, a variety of synthetic hydrophobic films has been studied to mimic the natural surface by enhancing the surface roughness of the underlying organic film (PAH/PAA) [3]. Chemical etching of glass substrate followed by deposition of silicon dioxide (SiO₂) nanoparticles and organic molecules has been employed for preparing the coated glass with finer-scaled roughness and lower surface energy. The fabricated films on glass substrate exhibits water contact angle higher than 150° as well as self-cleaning and anti-adhesion properties. However, information of incorporating the advantages of ZnO and polyelectrolyte layer for a control of hydrophilic and hydrophobic property of coated substrates is still limited. Such combination of ZnO and polyelectrolyte compounds would provide a promising alternative for substrate surface modification.

The main purpose of this work was to investigate the hydrophilic properties of the polyelectrolyte multilayer films incorporated with ZnO nanoparticles under the effect of UV irradiation. The ZnO thin film was fabricated to mimic the natural surface by controlling the dipping cycle, resulting in the varied surface roughness of

the underlying organic layer (PAH/PAA). The organic layers were prepared by the combination of electrochemical deposition and layer-by-layer technique and then followed by the deposition of ZnO nanoparticles using dip-coating method.

1.2 Objectives

Objective of this thesis was to investigate an effective method to deposit ZnO nanoparticles thin film on polyelectrolyte layer depositing on glass substrate using the dip coating technique and then examine the hydrophilic properties of the coated glass substrates after employing UV irradiation.

1.3 Scope of work

1.3.1 Determine the optimal condition for controlling the surface roughness by varying the following parameters :

1.3.1.1 Concentrations of polyelectrolytes: 0.02, 0.20, 0.50, 1.00, and 2.00 M

1.3.1.2 Withdrawal speeds: 3.0, 6.0, and 9.0 cm/min

1.3.1.3 Number of dipping cycle

1.3.2 Analysis the viscosity of polymer using Rheometer to investigate the effect of viscosity of polymer on the film thickness

1.3.2 Determine the suitable method for depositing ZnO nanoparticles on polyelectrolyte film

1.3.3 Study the effect of UV irradiation time: 15, 30, and 60 min (using the UV-A lamp (SAPHIT A.J.L. Supplies, Thailand) with emission wavelength in a range of 300-460 nm and output of 20 watts)

1.3.4 Characterize ZnO incorporated with PET film by UV-VIS (UV-Vis spectrophotometer), CLSM (confocal laser scanning microscope), FE-SEM (field emission scanning electron microscope), EDX (energy dispersive spectrometer x-ray), AFM (atomic force microscope), FTIR (fourier transform infrared) and Contact angle measurement