CHAPTER I
INTRODUCTION

Energy is a fundamental factor for the quality of human life. Almost energy in the global is generated from fossil fuels such as coal, petroleum, and natural gas. Nowadays, there is a significant decrease in fossil fuels and their combustion can also severely harm the environment. Hence, people have increasingly attracted in renewable energy as sunlight due to clean energy, non-produce carbon dioxide, sustainable energy and acceptable for public.

The conversion from solar energy to electricity is carried out by 'solar cell'. One of the traditional solar cells is the single-crystalline silicon solar cells. They operate on the principle of p-n junctions and can reach 20% conversion efficiency in commercial design. However, because of high material and production cost, in 1991, O'Regan and Grätzel have successfully developed a photovoltaic device with 7% conversion efficiency, which is called 'Dye-sensitized solar cell' (DSSC). In 1993, Nazeeruddin *et al.* reported the high conversion efficiency with 10%. DSSC is a new type of solar cell and considered as an alternative to the single-crystalline silicon solar cells due to the lower production cost.

The principle of DSSC is similar to the photosynthesis of plant. DSSC composed of sensitized dye, semiconductor, electrolyte and counter electrode. The sensitized dyes are used to enlarge the spectral absorbance, which are divided into two kinds: natural dyes and synthetic dyes. The metal oxide semiconductors are used for the absorption of dye and the enhancement of stability. For example, zinc oxide (ZnO) has been explored as an alternative material semiconductor electrode instead of the typical TiO_2 in dye-sensitized solar cells because ZnO has a similar band gap to TiO_2 and its electron mobility is higher than TiO_2. There are several techniques to prepare ZnO electrode such as doctor blading, electrophoretic deposition (EPD) and screen printing. Doctor blading is a facile method which is used to fabricate DSSC. Recently, electrophoretic deposition (EPD) is a well-known technique for fabricating DSSC and obtaining highly uniform films without binder and thickness can be controlled by changing the applied voltage and deposition time. In 2009, Saito *et al.* reported the conversion efficiency with 4.3% of ZnO/N-719 photoanode for DSSC which was fabricated by doctor blade method. Because synthetic dyes are very expensive, natural dyes are the alternative as sensitizer. In 2011, Chandrasekaran *et al.* have reported efficiency of 1.645% for ZnO with natural dye extracted from jambula. However, ZnO with natural dyes which are fabricated as photoanode in DSSC still have lower conversion efficiency when compare to synthetic dyes.

One of the problems of low conversion efficiency is a recombination reaction of the photoinjected electrons in the conduction band of the semiconductor with the oxidized dyes and the triiodide in the electrolyte. To reduce recombination reaction, conductive polymers (CP) such as polythiophene, polypyrrole are promising candidates for application in DSSC as energy barriers layers. In 2000, ZnO/Ru(II)/Polypyrrole electrode as photoanode was fabricated and obtained a high conversion effciency of 1.3% (Hao *et, al, 2000*). In 2009, Lee *et al.* reported the power conversion efficiency of DSSC with polythiophene layers on TiO_2/Ruthenium photosensitizer was 6.01%. So far there has no report about the fabricating ZnO as photoanode with polythiophene as energy barrier.

Therefore, this study has strongly focused on an investigation of ZnO/natural dye/polythiophene as photoanode in DSSC device in term of photo conversion efficiency. The ZnO layer was fabricated by doctor-blading and electrophoresis deposition method. The extracted natural dyes have been employed as sensitizer for DSSC. The polythiophene, energy barrier, is deposited on ZnO/dye electrode by electropolymerized deposition. The crystal structures of ZnO layer were identified by X-ray diffraction (XRD). The surface morphologies were studied by field emission scanning electron microscopy (FE-SEM). Film thicknesses were determined by profilometer and FT-IR were identified the deposited sample on FTO glass. The optical property of electrode was measured by UV-Vis spectrophotometer. The photovoltaic properties were determined by a digital Keithley 236 multimeter.