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# Effect of Surfactants to The Electrical Properties of The Hole Transporting Layer of Organic Solar Cells

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**Abstract**

Nowadays, Organic Solar Cells (OSC) become one of the alternatives to replace inorganic solar cells towards roll-to-roll process. For OSC, hole transporting layer (HTL) plays an important role as this layer also contributes to the increase in efficiency of OSCs. The conductivity of HTL increases the efficiency of charge collection at anode. In this study, the effect of different surfactants which are dimethyl sulfoxide (DMSO) and Triton X-100, covering different concentrations and temperatures toward the HTL conductivity are studied and analyzed by using two-probe method. It is found that the conductivity of HTL increases by concentration as well as higher temperature, meanwhile DMSO shows higher conductivity than Triton X-100.

***Keywords:*** *Hole transporting layer, surfactants, conductivity.*

## 1. Introduction

Inorganic solar cells have some limitations in terms of processing methods and moving towards flexible substrates. One of the alternatives to overcome the limitations is by using Organic Solar Cells (OSC). In OSC, it is possible to fabricate the cells by using solution process which is also suitable for roll-to-roll (R2R) process [1]. OSC consists of several functioning layers such as indium tin oxide (ITO), hole transporting layer (HTL), active layer (AL) and metal electrode which is usually either gold (Au) or silver (Ag). It is important to have high conductive HTL in order to improve the efficiency of the OSC. One of the most widely used HTL is poly(3,4-ethylenedioxythiophene): poly (styrene sulfonate) (PEDOT: PSS) [2]. Although it has disadvantages such as degrading the metal electrode in inverted structure [3], it is still widely used as a HTL. Sorbitol dimethyl sulfoxide (DMSO) and ethylene glycol (EG) are commonly used surfactants to increase the conductivity of the PEDOT: PSS [4-6]. Triton X-100 is another surfactant that is used to improve the wettability of PEDOT: PSS on other polymer layers [6-7]. Still very few researches have been conducted to investigate the effect of Triton X-100 to the conductivity of the PEDOT: PSS film. To further investigate the effect of surfactant to the HTL conductivity, in this study we add Triton X-100 and DMSO at different concentration to the PEDOT: PSS Clevios PH1000. Two probe method is used to measure the resistivity before converting to the conductivity [8].

## 2. Materials and Methodology

The glass substrates are cleaned by sonicating them for 10 minutes in acetone, deionized water and isopropanol, respectively. PEDOT: PSS CLEVOIS PH 1000 is purchased from Heraeus, meanwhile DMSO and Triton X-100 are purchased from Sigma Aldrich. PEDOT: PSS solutions are prepared with different conditions which are PEDOT: PSS only, PEDOT: PSS with 1.0 wt% and 2.0 wt% of DMSO, and PEDOT: PSS with 1.0 wt% and 2.0 wt% of Triton X-100. The solutions are stirred for 5 hours before spin coated on the substrates at 1000 rpm for 60 seconds. Then, the substrates are heated at 200°C for 10 minutes. The resistivity of the substrates is measured by using two probe system with a Keithley 2450 source meter and calculated using Eq.1 before converted to the conductivity by using Eq.2. The surface morphologies are characterized by using Scanning Electron Microscope (SEM).

$$\rho = \frac{VA}{IL} \tag{1}$$

$$\sigma = \frac{1}{\rho} \tag{2}$$