ABSTRACT

DSSCs performance can be enhanced by modifying the morphology of photoelectrode. Titanium dioxide, TiO$_2$, is the most used oxide semiconductors for DSSC photoelectrode. Anatase and rutile TiO$_2$ are widely explored in DSSC for high photocatalytic activity and high light scattering ability, respectively. However, ZnO-based DSSC is interesting to be developed due to the higher position of the conduction band compared to the conduction band of TiO$_2$ allowing possibility to generate higher photovoltage. In this study, bilayer and monolayer of TiO$_2$-based and ZnO-based DSSCs were fabricated. TiO$_2$ and ZnO nanoparticles were synthesized by co-precipitation method using precursor of TiCl$_3$ and ZnAc dihydrate, respectively. All of TiO$_2$-based DSSSs were sensitized with natural dye anthocyanin extracted from mangosteen pericarp and Ru-based dye (N719). ZnO-based DSSCs were only sensitized with N719 dye.

The results show that bilayer TiO$_2$-based DSSCs could enhance the light harvesting efficiency by extending the optical path length of incident photon. Enhanced light harvesting efficiency is indicated by high magnitude of IPCE spectra in the range of visible light wavelength. Photoelectrochemical properties of DSSCs confirm that the enhanced light harvesting efficiency affects to the enhancement of conversion efficiency of DSSCs. In addition, anthocyanin dye has comparable performance to N719-dye. This is indicated by the result of bilayer anatase structure which could generate conversion efficiency of 0.461% and 0.45% for anthocyanin dye and N719-dye, respectively. Among ZnO-based DSSCs, monolayer DSSC using monodisperse ZnO particles are able to generate higher conversion efficiency than the one using polydisperse ZnO. Bilayer ZnO-based DSSCs can optimize the photocurrent action spectra in UV regime leading to high conversion efficiency. However, the longer sensitizing time of ZnO photoelectrode can induce the dissolution of Zn atoms and formation of Zn$^{2+}$-dye that able to resist the electron transport from dye to ZnO photoelectrode.

Keywords: DSSC, Light harvesting, TiO$_2$, ZnO, IPCE, Conversion efficiency.