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Synthesis and characterization of photoanodes for dye-sensitized solar cells prepared by TiO_2 P25 / P90 nanoparticle mixture

K. Umair[1*], M.A.K.L. Dissanayake[1], G.K.R. Senadeera[1,3], J.M.K.W. Kumari[1,2], C.A. Thotawatthage[1], T. Jaseetharan[1,2,4]

[1]*National Institute of Fundamental Studies, Kandy, Sri Lanka*
[2] *Post Graduate Institute of Science, University of Peradeniya, Sri Lanka*
[3] *Department of Physics, The Open University of Sri Lanka, Nawala, Nugegoda, Sri Lanka*
[4]*Department of Physical Sciences, South Eastern University of Sri Lanka*
**** umair.ka@nifs.ac.lk***

Dye-sensitized solar cells (DSSCs) are emerging as promising candidates to replace expensive silicon solar cells because of reasonably high efficiency, easy fabrication method, lower production cost and transparency. Nanostructured semiconductor films are the backbone of DSSC photoanodes. The photoanode performs a dual role as the support for the sensitizer (dye) loading and transporter of photo-excited electrons from the sensitizer to the external circuit. Therefore, to ensure the high dye loading the effective surface area of the photoanode should be large. Moreover, a fast charge transport rate is essential to ensure high electron collection efficiency. Photoanodes of DSSCs are generally made of TiO_2 nanoparticles of diameters in the range of 15-25 nm. This is due to the wide energy band gap, nontoxicity and large specific surface area, which facilitate the enhanced dye adsorption. In this project, photo anodes were prepared by mixing commercial P25 TiO_2 (particle size ~22 nm) and P90 TiO_2 powders (~14 nm) with different weight percentages. After sintering the composite photoanode at 450 °C for one hour in air, the powdered samples were analyzed by the X –ray diffractometry to identify the ratio of the anatase and rutile phases present in the photoanodes. UV-VIS spectroscopy was used to determine the effective energy band gaps. SEM images were used to estimate the particle sizes present in the powder samples of P25 and P25:P90, 70:30 mixture. Results show that the percentage of rutile phase is high and the effective optical bandgap is lower in the 100% P25 powder than P25:P90, 70:30 mixture. However, preliminary measurements on DSSCs made with the composite photoanode showed better performance compared to a DSSC made with only P25 TiO_2 photoanode.

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