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# *Pore size enhancement in $TiO_2$ thin films and its effects on dye sensitized solar cells*

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***Abstract***

Light harvesting efficiency in dye sensitized solar cell is currently enhanced by the employment of an additional $TiO_2$ scattering layer hence increasing the overall film thickness. This has limitations on effective charge transport especially in dense electrolyte media due to the increased film thickness. The additional film layer further reduces light intensity on the adsorbed dye hence decreasing photocurrent generation. Therefore, there is still the challenge of light scattering optimization versus charge transport and photocurrent generation. In addition, though $TiO_2$ is a relatively cheap material, the addition of $TiO_2$ layer raises the production cost of the dye sensitized solar cell effectively and rendering it not cost effective. In this study, carbon black was employed to create artificial pores in $TiO_2$ thin films to enhance light harvesting and hence photocurrent generation. TiO2 films deposited by screen printing method had 0, 1.0, 1.5, 2.0 and 3.0 wt% carbon black. On annealing of the films at 500oC in air for 30 minutes, carbon black decomposed leaving behind voids. Transmittance, reflectance and absorbance spectra of the films determined by a UV-Vis-NIR show that transmittance decreased as the carbon black concentration increased. On the other hand, both reflectance and absorbance increased with increase in carbon black concentration. Micrograph images obtained from both Scanning Electron Microscope (SEM) and Atomic Force Microscope (AFM) show that the pore size of the films increased as the carbon black concentration increased. Furthermore, the XRD results of these films show that the TiO2 are anatase and without any carbon contamination. Conductivity of the films determined using a four point probe was found to decrease with increase in pore size due to decrease in electrical contacts among the $TiO_2$ molecules. The values 384.61, 352.11, 103.41, 52.41 and 35.29 Siemen's cm-1 were determined for 0, 1.0, 1.5, 2.0 and 3.0, respectively. Current-Voltage (*I-V*) characteristics of the cell fabricated with different pore sizes were determined using a solar cell simulator at 100 mW/cm2 illumination. The results show that photocurrent generated by these cells increased from 6.1 mA/cm2 to a maximum value of 9.9 mA/cm$^2$ as the wt % carbon black increased from 0 wt% to 1.5 wt %, respectively. Beyond 1.5 wt%, photocurrent begun to drop until it got to its minimum value of 4.7 mA/cm$^2$ at 3.0 wt%. The overall efficiencies for 0, 1.0, 1.5, 2.0 and 3.0 wt% were found to be 2.3, 2.6, 4.3, 2.4 and 1.4 %, respectively. The result shows an improvement in the photovoltaic performance of DSSC as a result of the artificial voids created. However, beyond the optimum concentration of 1.5 wt%, the cell performance begun to decline. This approach greatly enhanced the current density of the cells and consequently the overall conversion efficiency significantly.

***Biography:***

Dinfa L. Domtau has completed his PhD at the age of 37 years from University of Nairobi, Kenya. He also visited the Institute of Energy and Climate Change Research, Julich, Germany for six months for his PhD research. He is a Lecturer at the Department of Physics, University of Jos, Jos, Nigeria. He has published more than 14 papers in reputed journals.

***Speaker Publications:***

1. D. L. Domtau, J. Simiyu, E. O. Ayieta, l. O. Nyakiti, B. Muthoka and J. M. Mwabora, Effects of $TiO_2$ film thickness and electrolyte concentration on photovoltaic performance of dye-sensitized solar cell, Surface Review and Letters, Vol. 24, No. 05, 1750065 (2017).
2. D.L. Domtau, J. Simiyu, E.O. Ayieta, B. Muthoka, J. M. Mwabora. Optical and Electrical Properties Dependence on Thickness of Screen-Printed TiO2 Thin Films. Journal of Materials Physics and Chemistry. 2016; 4(1):1-3. doi: 10.12691/jmpc-4-1-1.

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