Improvement of solar cells efficiency through detailed characterization of TCO/ TiO_2 interface

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ABSTRACT

Solar power can easily meet the demands of electrical power for whole world if only we could decrease the power to price ratio for solar panels [1]. One of the possible way is to reduce the production cost and as so the third generation of solar cells such as DSSC (Dye Sensitized Solar Cell) [2] and QDSC (Quantum Dots Solar Cell) [3] were introduced. Nonetheless there is still some issues to be overcome. The typical structure of DSSC and as an simple adaptation for QDSC is based on glass with TCO layer and then using screen printing a mesoporous layer of TiO2 is deposited. It seems that the interface between TCO and TiO2 layer may be important when thinking about improving the final power output. To increase the final efficiency of the solar cell one can improve the charge transfer between the photoelectrode and TCO layer. In our case the TCO layer is prepared using magnetron deposition process and made from Sn_2O_3:F. The thickness measured using ellipsometry spectroscopy was found to be in range of 600 nm. The crystalline structure of TCO is rather rough and not regular on its surface. On the top of TCO layer using screen printing the TiO_2 layer form TiO_2 paste of a thickness of about 1-2μm was deposited. After deposition the layer has been subjected to drying and firing. High resolution SEM measurements done in cross section configuration show the gap between these two layers what could significantly decrease charge transfer. In order to overcome this problem we propose to use high energy grinding process to reduce the size of TiO_2 particles and then prepare paste which in turn will be used to made TiO_2 layer. So far the particles size of TiO_2 was mainly studded in order to increase the adsorption of dye [4], or diffusion and recombination in dye-sensitized TiO_2 solar cells [5]. After grinding process we use XRD measurements to find out about the TiO_2 particle size and we found that starting from diameter of 290 nm, after 18 hours one can obtain the diameter size in range of 15 nm. The size was estimated using Scherrer methods. We observe that by using paste based on small TiO_2 particles size the gap between TCO and TiO_2 layers decreases significantly or disappears. This will lead to increase in total efficiency of solar cell.

References

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