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Synthesis and characterization of meso-5-(4-hydroxyphenyl)-10,15,20-tris(4-methoxyphenyl)porphyrin and its use as a photosensitizer in nanocrystalline zinc oxide solar cell

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Meso-5-(4-hydroxyphenyl)-10,15,20-tris(4-methoxyphenyl)porphyrin [H_2HPTrMPP] was synthesized starting from pyrrole, *p*-hydroxybenzaldehyde and *p*-methoxybenzaldehyde in propanoic acid medium and the product was separated by the column chromatography using $CHCl_3$:CH_3OH (95:5V/V) as the eluant; violet coloured product was obtained upon the rotary evaporation of the solvent. The product had intense Soret absorption band centered at 419 nm and four Q bands of lower intensity in the range 510 nm to 700 nm in the UV-visible absorption spectroscopy. The product was also characterized by ^{1}H-NMR and FT-IR spectroscopic techniques and by cyclic voltammetry; all of which supported to identify the product to be H_2HPTrMPP. H_2HPTrMPP was then metallated with Zn^{2+} to yield ZnHPTrMPP. The UV-visible absorption spectrum of ZnHPTrMPP had the typical Soret absorption band centred at 419 nm but the four bands in Q-band reduced to two as expected. Also in ^{1}H-NMR of the metallated product, the signals due to N-H which was observed in H_2HPTrMPP disappeared.

Nanoparticles of ZnO was prepared by the sol-gel process using zinc acetate dihydrate with NaOH in methanol at 55 ^oC. Cetyltrimethylammonium bromide(CTAB) was used as the particle growth controller. The precipitate obtained was separated by filtration, washed several times with methanol and then with distilled water and the thick viscous solution was autoclaved at 60 ^oC. The X-ray diffractometry confirmed the purity of ZnO and the particle size calculated using the Debye-Scherer equation was around 9 -18 nm.

Several (11 in number) solar cells of the configuration ITO/ZnO/ZnHPTrMPP/I_2, I^- in water or dimethyl sulphoxide/Pt-ITO were prepared by utilizing both doctor blading and dip coating methods to deposit ZnO on ITO and their performances, i.e., Open Circuit Voltage V_{oc}, Short-circuit current I_{sc} and the Fill Factor FF, were determined. The cells with best performance has V_{oc} of 0.7 V, I_{sc} of 136 □A and FF of 0.41. The energy level diagram was constructed using experimental results obtained in spectroscopic and electrochemical studies carried out in this work and the thermodynamic feasibility of the cell performance confirmed.

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