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Effect of carbon modification on the electrical, structural and optical properties of TiO₂ electrodes and their performance in lab-scale dye sensitized solar cells

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Carbon modified titanium dioxide nanoparticles (C:TiO₂ NPs) have been synthesized by ultrasonic nebulizer spray pyrolysis (USP) and pneumatic spray pyrolysis (PSP) techniques using titanium tetraethoxide as the precursor solution. High resolution transmission electron microscopy on the NPs shows difference in lattice spacing in the NP structures prepared by the two methods – 2.02 Å for the USP NPs and an average of 3.74 Å for the PSP NPs. The most probable particle sizes are 3.11 nm and 5.5 nm respectively. The carbon doping only changes the lattice spacings of the TiO₂ lattice; the most predominant plane is the (101) in TiO₂ reciprocal lattice as determined from the fast Fourier transform of most of the particle images. Raman spectroscopy supported by FTIR confirms the TiO₂ polymorph to be anatase with the intense phonon frequency at 153 cm⁻¹ blue-shifted from 141 cm⁻¹ due to both carbon doping and particle size. A modified phonon confinement model for nanoparticles has been used to extract phonon dispersion and other parameters for anatase for the first time. Electronic measurements show “negative conductance” at some critical bias voltage, which is characteristic of n-type conductivity in the carbon doped TiO₂ NPs as confirmed by the calculated areas under the I-V curves. This is a necessary material property for the Grätzel type of solar cells application. Practical solar cells built from carbon doped TiO₂ electrodes show up to 5 times improvement in efficiency compared to pure TiO₂ electrodes of similar construction.

Level (Hons, MSc, PhD, other)?

phD

Consider for a student award (Yes / No)?

Yes

Would you like to submit a short paper for the Conference Proceedings (Yes / No)?

YES

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