**Supporting Information**

**Apparatus-Dependent Sol-Gel Synthesis of TiO2 Nanoparticles for Dye-Sensitized Solar Cells**

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**2** **EXPERIMENTAL SECTION**

**2.1 Chemical used**

All chemicals are commercially purchased by Sigma-Aldrich and used without further purification. Titanium-tetra isopropoxide (TTIP) has purity (99.9 %) and glacial acetic acid was purchased from Aldrich. Deionized (DI) water was used for preparing aqueous solution. PEDOT: PSS (2.8 wt. % of H2O) was purchased by Sigma-Aldrich. All the glass wares used in experiment were thoroughly cleaned with freshly prepared liquid soap and then rinse with DI water, acetone and propanol before use.

**2.2 Synthesis of TiO2 nanoparticles**

The sol-gel synthesis technique was adapted to prepare colloidal TiO2 and this process yields colloids of semiconductors that can be cast as stable films on suitable substrates. 250 mL of DI was taken in a 1000 mL round bottom flask. Glacial acetic acid and 2-propanol was added in a (1:8) ratio to the water followed by 37 mL of Ti (IV) isopropoxide and fresh Ti (IV) isopropoxide solution was used for the synthesis. The dropping solution slowly dripped at a rate of approximately one drop per second over the course of 30-40 min. The water/acetic acid solution was vigorously stirred during the addition process and then resultant solution placed less than 100 °C water bath. The solution was heated with vigorous stirring. As the solution warms and observed to become gel-like. At that point, the heater was stopped and the solution was allowed to cool. Cooling process is gradual and returns the gel-like viscous solution to a liquid state. Once the heating was finished, the colloidal solution was loaded into two different apparatus one is made up of stainless steel and other has teflon coating (~ 500 mL). These apparatus has constant pressure, it was placed in the oven set to a maximum temperature of 220 °C (varies depending on desired particle size, larger particles require higher temperatures) for 12 h. After 12 h, the oven was switched off and the contents were allowed to cool to room temperature over a period of 24 h. The entire solid fraction settled down at the bottom of the apparatus. In stainless steel apparatus crystal form in black color and in autoclave apparatus formation of crystal in white color due to teflon lining, because teflon thermal coefficient is more than stainless steel apparatus. TiO2 nanoparticles synthesized in stainless steel and in autoclave apparatus were named as TiO2-B and TiO2-W, respectively and compared with commercial TiO2 nanoparticles named as TiO2-C.

**2.3 Synthesis of TiO2 Paste**

Two kinds of pure ethyl cellulose (EC) powders, i.e., EC (5-15 mPas, #46070, Fluka) 2.8 gm and EC (30-50 mPas, #46080, Fluka) 2.1 gm were dissolved prior to usage in 5 mL ethanol. An amount of 0.5 mL of acetic acid was added at once to 1 gm of TiO2 anatase powder (7 nm) under stirring at room temperature. The modified solution was stirred and sonicated for about 15 min and poured into 1 mL DI water as quickly as possible while vigorously stirring (700 rpm). 1 h of stirring was required to achieve a complete reaction. After adding a quantity of 1 mL of ethanol, then stir and sonicate for 15 min at room temperature. 5 gm of terpineol (anhydrous, #86480, Fluka) added in final solution. This mixture was then sonicated using an ultrasonic-horn, alternating stirring, with a hand mixer, and sonication, for three consecutive times. Ethanol and water were removed from these TiO2/ethyl cellulose solutions by rotary-evaporator (initial temperature 40 °C and pressure 120 mbar subsequently reduced to a final pressure of 10 mbar at 40 °C).

**2.4 Fabrication of dye-sensitized solar cells**

Two types of photoanodes were prepared by screen printing technique on FTO (7 Ω/□, Pilkington) glass; one was using paste of TiO2-B and second was with paste of TiO2-W nanoparticles. TiO2 paste [[1](#_ENREF_1)] was prepared according to the procedure mentioned in[[2](#_ENREF_2)] .The thickness of first layer screen printed by these paste was ~ 9 µm thickness. Above these layers a scattering layer of ~ 5 µm thick was again deposited by screen printing technique using DSL 18NR-AO paste[[3](#_ENREF_3)]. The complete photo-anodes were annealed using a ramping program on hot plate. After cooling, these photoanodes were further treated with 40 mM aqueous TiCl4 solution at 80 °C for 30 min. TiCl4 treated photoanodes were again annealed at 450 °C for 30 min. The photoanodes cooled up to 80 °C were dipped in 0.5 mM N719 dye (Dyesol) in acetonitrile: t-butyl alcohol (1:1) solution for ~ 20 h. For platinum (Pt) counter electrode (CE) deposition, a solution of H2PtCl6 in ethanol (2 mg mL-1) was drop cast on FTO (7 Ω/□, Pilkington) coated glass followed by sintering at 410 °C for 15 min. The DSSCs were sandwiched by sealing the sensitized photoanodes and CEs with a 25 mm thick Surlyn polymer spacer. DSSCs containing photoanodes of TiO2-B paste and TiO2-W paste were named DSSC-TiO2-B and DSSC-TiO2-W, respectively. The iodine electrolyte consisting of 0.05 M lithium iodide, 0.05 M iodine, 1 M 1, 3-dimethylimadazolium iodide and 0.5 M 4-tert-butylpyridine (TBP) in acetonitrile: valeronitrile (85:15) was injected through a small hole in the CEs. Finally the holes in the CEs were sealed with Surlyn hot melt polymer and a glass slide. During the J-V measurement a mask of 0.20 cm2 area was put on the photoanodes of DSSCs to specify the active cell area. The J-V characteristics were measured under AM 1.5 G illumination (100 mW cm-2) using Oriel Sol 3 A, a class AAA solar simulator with Keithley 2440 source meter. The simulator was calibrated using an NREL certified Si solar cell.

**2.5 Characterization**

Powder X-ray diffraction (XRD) patterns (range 20-80 °) for the nanocrystals were recorded using a Bruker-AXS D8 advanced X-Ray diffractometer equipped with a Cu-Kα (λ=0.154 nm), X-ray source measured within the range (20-80 °) at the scanning speed of 0.01 deg s-1. Scanning Electron Microscope (SEM) images were recorded using Zeiss EVO MA-10 variable pressure SEM, samples being scanned at an accelerating voltage of 10.00 kV and WD of 12.00 mm at different magnifications from 1.00-30.00 KX under vacuum pressure of 10-6 torr. Raman spectra were analyzed using Renishaw Invia Raman Spectrophotometer, samples being scanned by argon laser having wavelength 514 nm. The FTIR spectra of samples were recorded in the wave number range 400-4000 cm-1 (at a resolution of 4 cm-1 and averaged over 32 scans) using a diamond attenuated total reflectance (ATR) assembly attached to the FTIR spectrometer (Nicolet 5700). Optical absorbance spectra of differently-capped nanocrystals dispersed in DI water was measured using a UV-2401 PC Shimadzu UV-Vis-NIR double-beam spectrophotometer. TEM measurements were done by JEOL make model JEM-200CX with an acceleration potential of 200 kV. Photoluminescence (PL) spectra and charge transfer (quenching phenomenon) was measured by Horiba TCSPS model number FL-1057 PL spectrophotometer.

**REFERENCES**

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