Supplementary Information SI-I

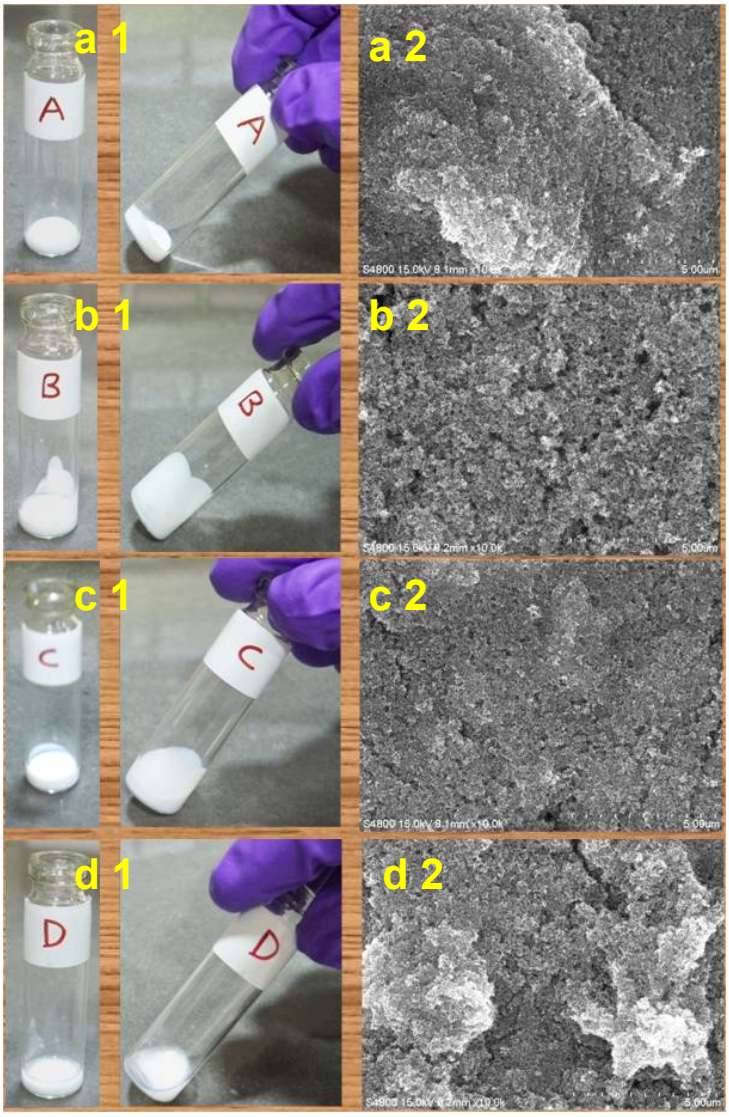
Experimental

Making of Room Temperature TiO_2 photoanodes: The TiO_2 paint was prepared using tertiary butyl alcohol (tBA) and water as solvents. Small amount of dilute acid (pH ~2) was also added to this mixture. Various weight ratios of tBA: TiO_2 were examined for optimization. After adding the desired amount of TiO_2 to this solvent system it was continuously stirred for several hours to get a viscous paste. The TiO_2 paint thus formed was coated on FTO/glass substrates as well as ITO-PET substrates using doctor blading technique. Application of the paint on the substrate by using a paint brush was also examined. Both the substrates were properly cleaned prior to paint application. TiO_2 layers with different thicknesses were realized by multiple application of the paint. After drying the films at room temperature they were soaked in 0.5mM N719 solution. Solar cells made with top electrode (Pt catalyst on FTO) and iodide-tri-iodide electrolyte were then made and tested for energy conversion efficiency and solar cell parameters. Impedance measurements were also carried out to examine the various resistances involved in the equivalent circuit.

Materials and Methods: Commercially available TiO_2 (Degussa, P25) was procured and used for making the solar paint. The N719 dye and Fluorine doped SnO_2 (FTO) electrodes (sheet resistance 15 ohm/square) were procured from Solaronix Co. The electrolyte used was 0.5 M 1, 2-dimethyl-3-propyl imidazolium iodide, 0.05 M LiI, 0.05 M I_2, and 0.5 M 4-tert-butylpyridine in acetonitrile/valeronitrile (v/v 1:1). The I–V characteristics were measured using a solar simulator (Newport) at 100 mW/cm^2 (1 sun AM 1.5). Standard Silicon solar cell (SER NO. 189/PVM351) from Newport, USA was used as reference cell. The measurements of incident-photon-to-current conversion efficiency (IPCE) were done using Quantum Efficiency Setup (Newport Instruments). Diffused Reflectance Spectroscopy (DRS, Jasco V-570 spectrophotometer), Field emission scanning electron microscopy (FE-SEM HITACHI S4800) and Electrochemical Impedance Spectroscopy (EIS, Autolab PGSTAT30 (Eco-Chemie)) were used to characterize the samples. The impedance measurements were performed at room temperature.

Supplementary Information SI-II

Figure SI-II shows the actual images and the FE-SEM images of the TiO_2 paint as the tBA: TiO_2 ratio is varied from low (2) to high (8). The (a1, a2), (b1, b2), (c1, c2), (d1, d2) cases correspond to the values of the ratio as 2, 4, 6, and 8, respectively.

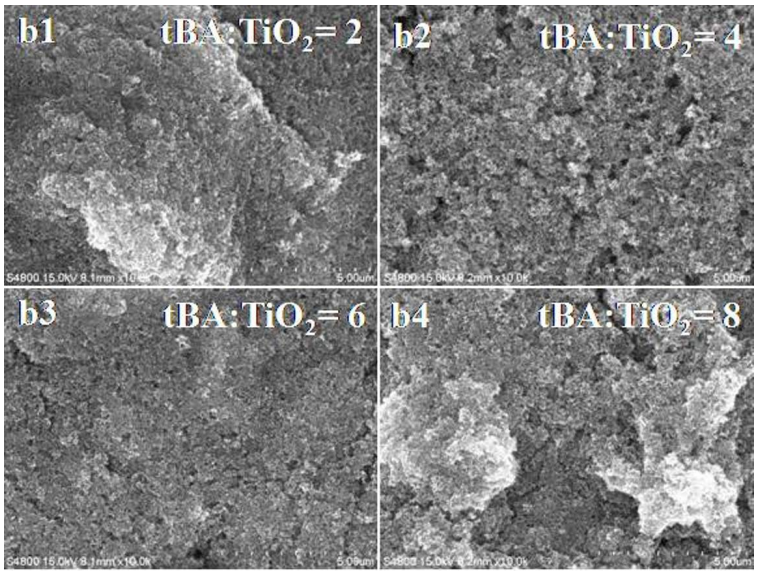


It can be seen that when the ratio is small (Figure SI-II (a2)) the film does not have a uniform texture and agglomerates are seen. It is also clear from Figure (SI-II (a1)) that the paste formed is too thick to be properly blade-coated or painted on a substrate. Also there is no proper necking between the particles (See SI-III (a)). When the ratio is increased, the film formed is of good quality maintaining proper porosity for dye loading as well as rendering good necking between the particles (Figure SI-II (b2)). The slurry/paste formed using this ratio forms a uniform coating on the side walls of glass vial

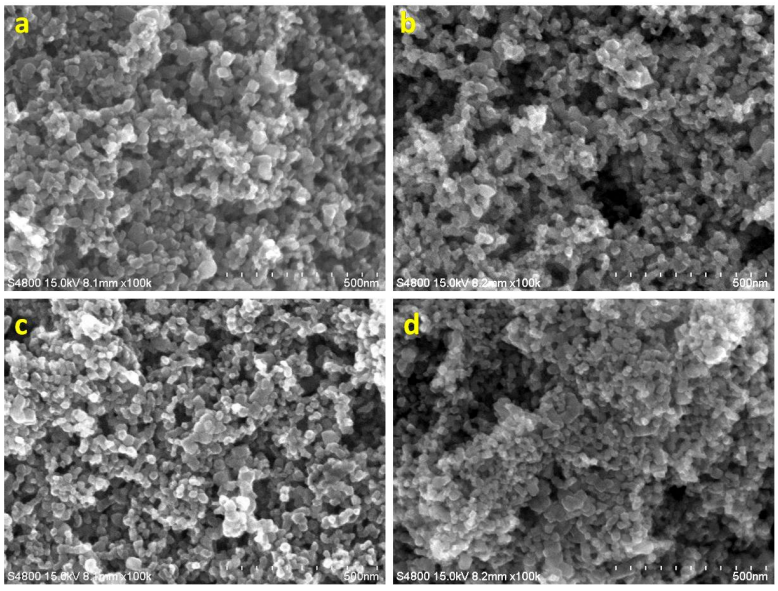
when tilted as seen in Figure SI-II (b1). When the ratio is further increased a uniform film is formed but there is slight decrease in film porosity (see Figure SI-II (c2)). As seen from Figure SI-II(c1) this paste also forms a coating on the walls of glass vial when tilted. When the concentration of tBA is very high compared to TiO_2 the film shows scattered clusters as seen in Figure SI-II (d2). Also the slurry formed is not homogeneous and it separates out from the solvent as seen in Figure SI-II (d1).

Supplementary Information SI-III

Supplementary information SI-III shows the FE-SEM images at a higher resolution.

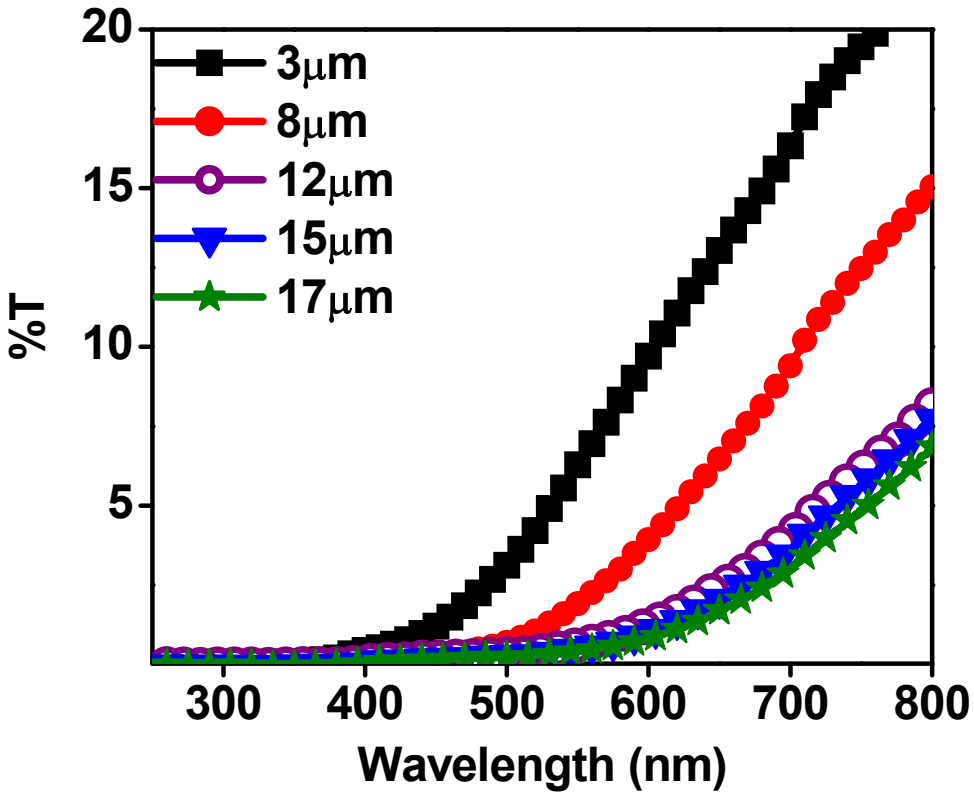


FE-SEM images of all four cases with tBA : TiO_2 ratio (b1) 2, (b2) 4, (b3) 6 and (b4) 8



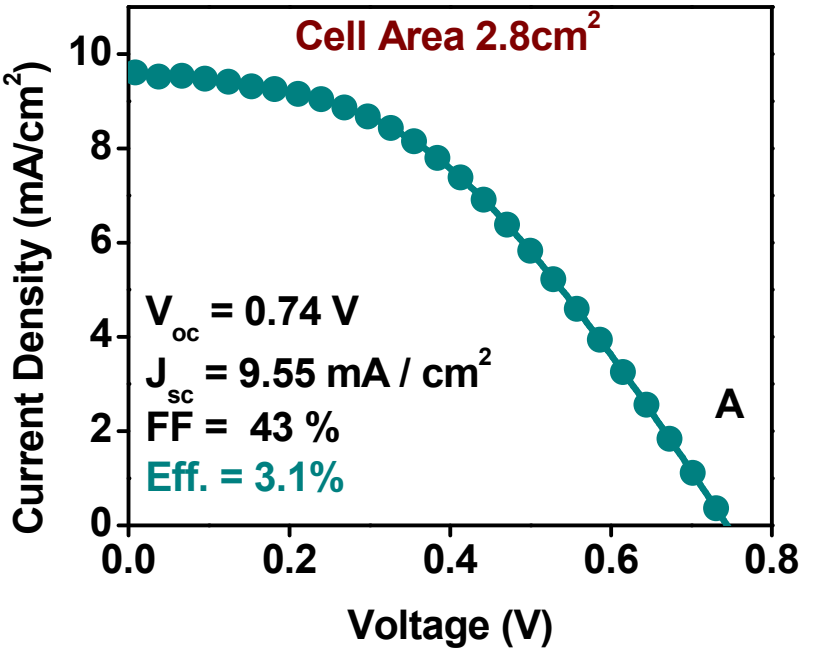
Magnified FE-SEM images for all the four cases with tBA: TiO_2 ratio 2 (a), 4 (b), 6 (c) and 8 (d).

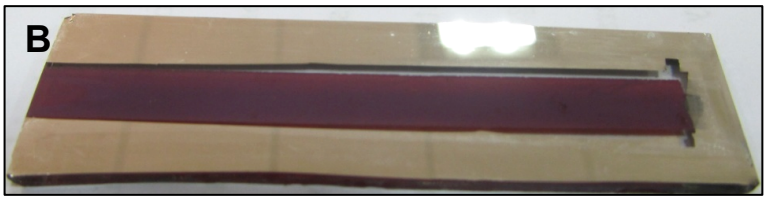
Supplementary Information SI-IV



Percent (%) Transmittance data as a function of film thickness for tBA: TiO_2 ratio 4: 1

Supplementary Information SI-V





(A) I-V Data of large area solar paint and (B) Image of Al metal deposited large area solar cell made from solar paint.