**Electronic Supplementary Information for New Journal Of Chemistry**

# Supplementary Information

## CdTe nanoparticles decorated titania for dye sensitized solar cell: A novel co-sensitizer approach towards highly efficient energy conversion

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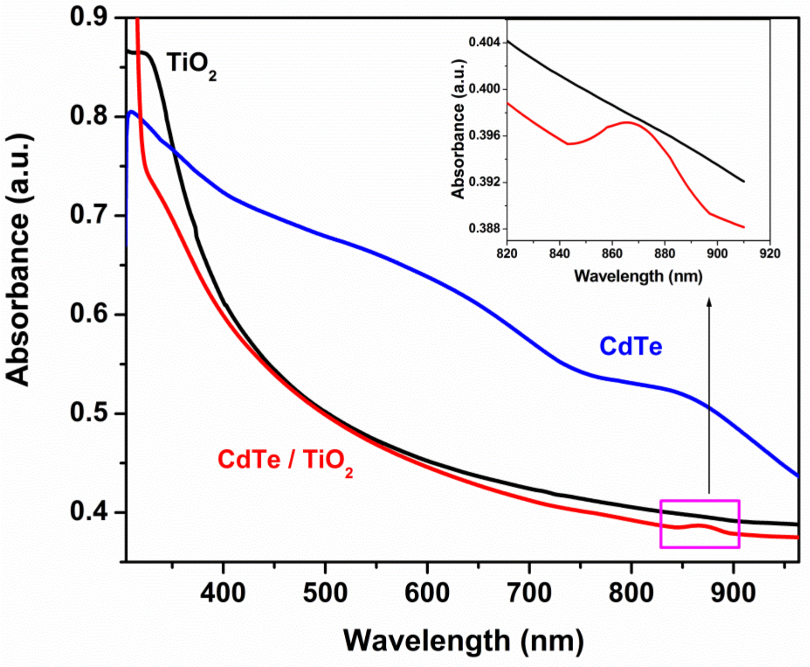


**Fig. S1.** UV Visible absorption spectra for $TiO_2$, CdTe, and $TiO_2$-CdTe matrices.

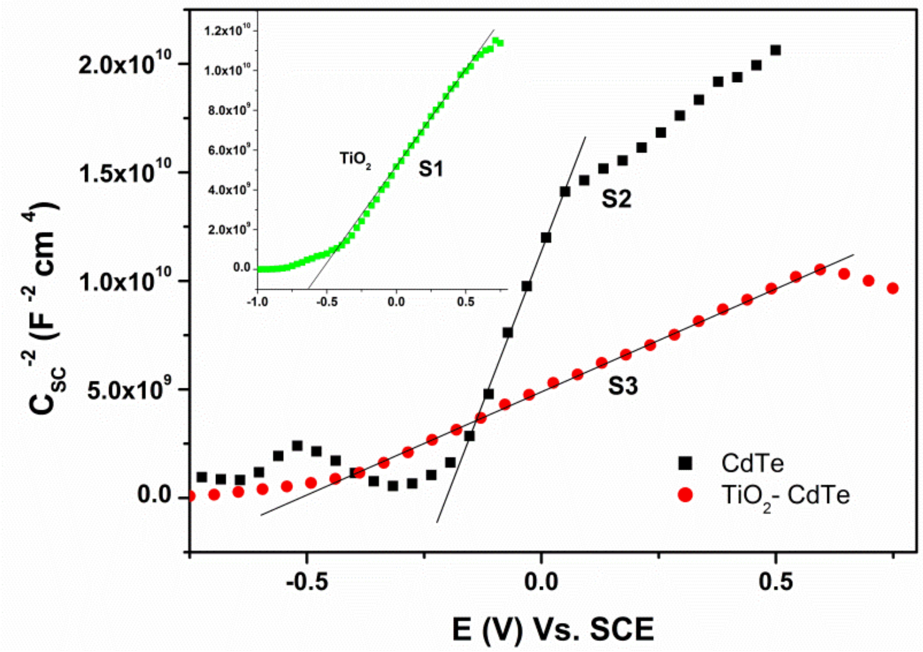


**Fig. S2.** Mott-Schottky plots of CdTe and $TiO_2$-CdTe/ $I^-$- $I_3^-$/ Pt system, (Inset : Mott-Schottky plot of $TiO_2$/ $I^-$- $I_3^-$/ Pt system).

The experimental work have determined the nature (carrier type) of the SCs and found each of the matrices $TiO_2$ (wide band gap), CdTe (low band gap) and the $TiO_2$-CdTe hybrid structure, belonging to the n type category and hence could be used as the DSSC anode components. The nature of the matrices were determined by the capacitance-voltage experiment as demonstrated below and relevant information were obtained using Mott-Schottky relation as reported in many of the earlier work **[J. Datta, A. Jana, C. Bhattacharya and S. Bandyopadhyay, *Electrochim. Acta*, 2009, 54, 5470–5478], [M. C. K. Sellers and E. G. Seebauer, *Thin Solid Films*, 2011, 519, 2103–2110], [R. V. D. Krol, A. Goosens, and J. Schoonman, *J. Electrochem. Soc*., 1997, 144, 1723-1727].**

$$\frac{1}{C^2} = \frac{2}{q\varepsilon\varepsilon_0 N_D}\left[V - V_{FB} - \left(\frac{KT}{q}\right)\right]$$

**Fig. S2** with the inset demonstrates the Mott-Schottky plots at a frequency 1 kHz using three electrode assembly cell consisting of the respective SC matrices as working electrodes, saturated calomel as reference electrode and Pt counter electrode in 0.05 M iodine-iodide solution as working electrolyte used for the DSSCs. The plots in **Fig. S2** exhibited positive slopes (S1, S2 and S3) for each of the matrices confirming n type semiconductor.

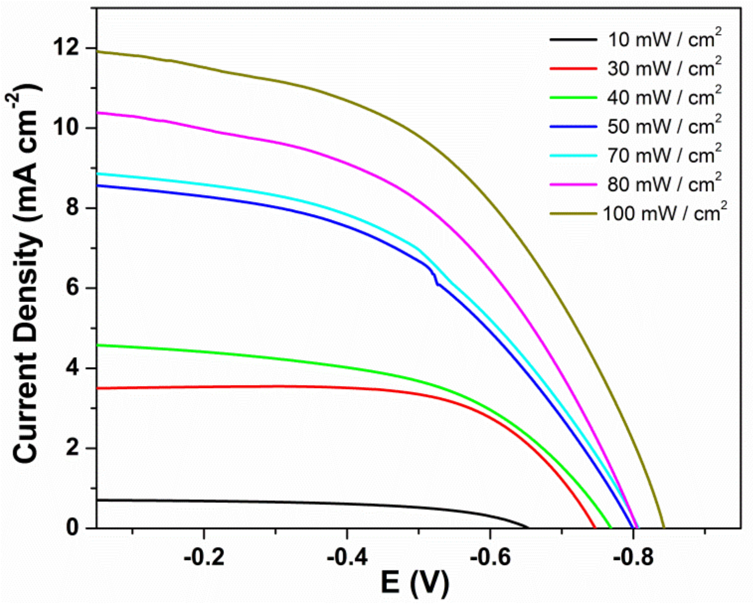


**Fig. S3.** Intensity variation of light illumination in *J*-*V* plot for $TiO_2$-N3 fabricated DSSC.

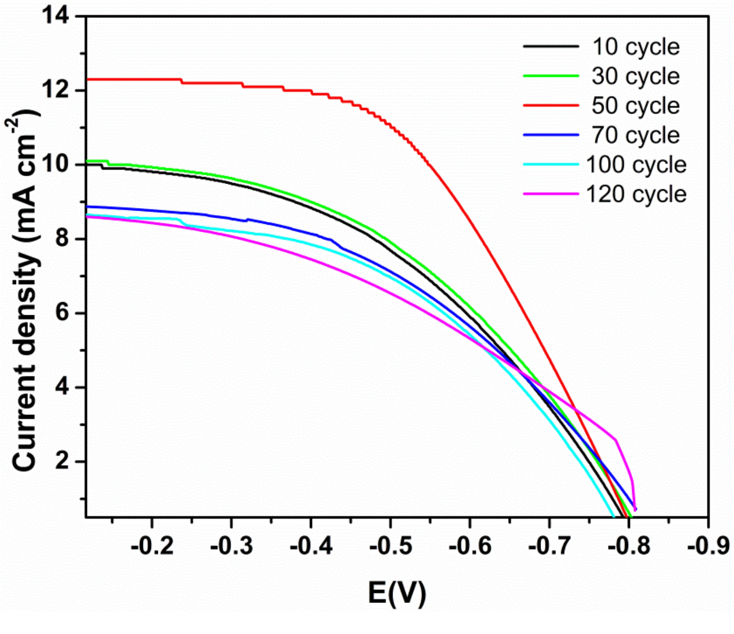


**Fig. S4.** *J*-*V* plot for the CdTe deposited under various scan in $TiO_2$ – CdTe -N3 fabricated DSSC under 50 mW cm$^{-2}$ light intensity

**Table S1.** *J*-*V* parameters recorded for $TiO_2$-CdTe-N3 fabricated DSSC at different cycles in cyclic voltammetric process for deposition of CdTe over $TiO_2$ and bare $TiO_2$-N3 system.

| Anode matrix | $J_{SC}$ (mA cm$^{-2}$) | η % | $V_{OC}$ (V) | FF (%) |
|---|---|---|---|---|
| $TiO_2$-CdTe(10) | 10.1 | 7.7 | 0.80 | 47.38 |
| $TiO_2$-CdTe(30) | 10.2 | 7.92 | 0.81 | 47.5 |
| $TiO_2$-CdTe(50) | 12.30 | 11.10 | 0.80 | 55.70 |
| $TiO_2$-CdTe(70) | 8.91 | 7.14 | 0.80 | 49.57 |
| $TiO_2$-CdTe(100) | 8.78 | 6.99 | 0.79 | 50.2 |
| $TiO_2$-CdTe(120) | 8.69 | 6.57 | 0.80 | 47.08 |
| $TiO_2$ | 8.63 | 6.69 | 0.79 | 48.53 |

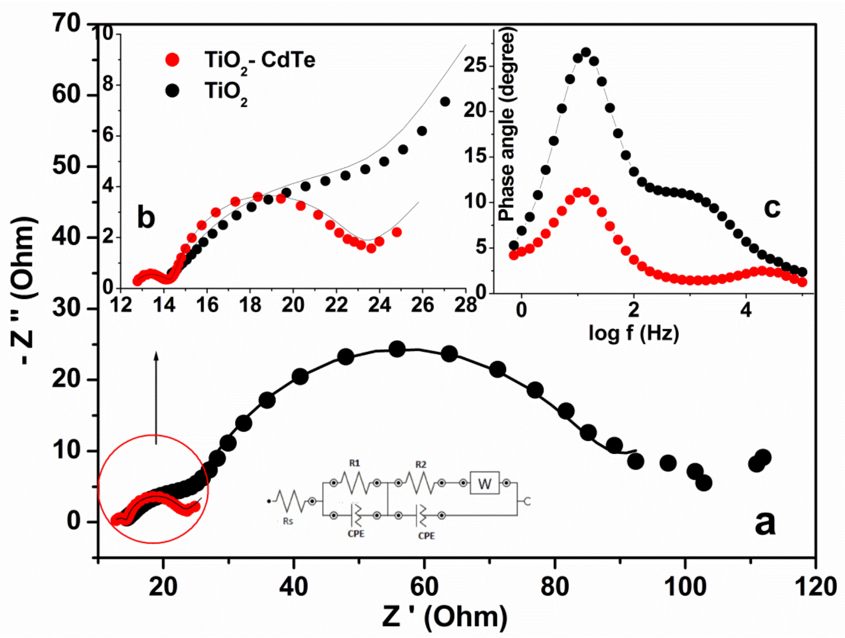


**Fig. S5.** (a) Nyquist diagram with fitted equivalent circuit for $TiO_2$ and $TiO_2$ – CdTe (50cycle)-N3 fabricated DSSC (Inset b: Magnified view of Nyquist diagram at high frequency region), (Inset c: Bode phase shift plot for the respective cells).

**Table S2.** EIS parameters obtained from equivalent circuit fitted Nyquist plots

| | $R_S$ (Ω) | $R_{CE}$ (Ω) | $R_{CT}$ (Ω) | CPE1(mMho) | CPE2(mMho) |
|---|---|---|---|---|---|
| **$TiO_2$-N3** | 14.1 | 13.3 | 61.1 | 0.414 | 0.586 |
| **$TiO_2$-CdTe-N3** | 12.4 | 1.97 | 8.30 | 0.303 | 3.06 |

It is to be noted that there is only 10 mV positive shift of $V_{OC}$ for CdTe modified system with respect to the bare $TiO_2$. Although the change is not very significant, huge difference in polarization resistance is obtained from the Nyquist plots as derived from the impedance spectra. $R$p for $TiO_2$-N3 is 70.47 Ω while that for $TiO_2$-CdTe-N3 is only 9.91Ω which indicate that the oxidative charge transfer process at the DSSC anode, requires much less threshold energy for the $TiO_2$-CdTe structure compared to $TiO_2$ alone. A number of reports are available which have demonstrated that with increase in $V_{OC}$ there is considerable reduction in polarization or charge transfer resistances **[J. Datta, A. Jana, C. Bhattacharya and S. Bandyopadhyay, *Electrochim. Acta,* 2009, 54, 5470–5478], [N. Yang, J. Zhai, D. Wang, Y. Chen and L. Jiang, *ACS Nano*, 2010, 4, 887–894].**

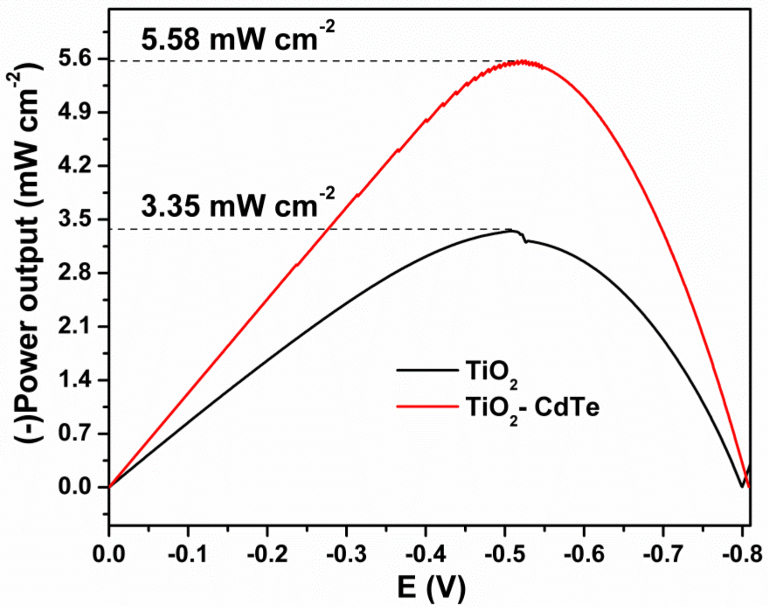


**Fig. S6.** Power output plot derived from *J-V* analysis of $TiO_2$ and $TiO_2$-CdTe matrix fabricated DSSC using N3 dye at 50 mW cm$^{-2}$.

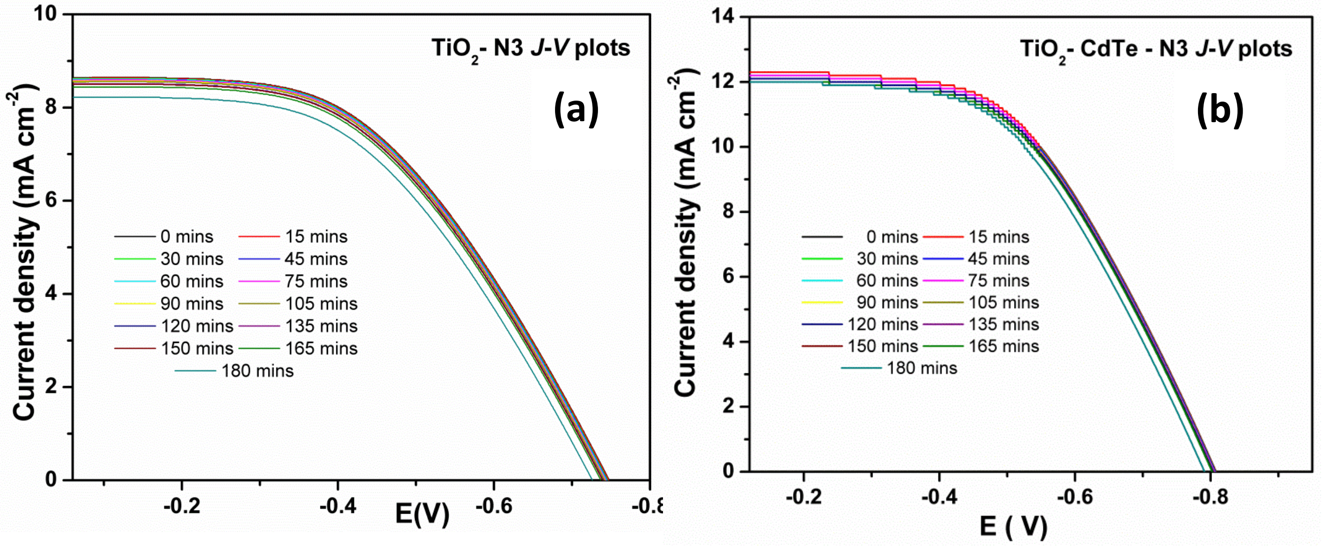


**Fig. S7.** (a) *J-V* plot of $TiO_2$ – N3 based DSSC under 50 mW cm$^{-2}$ for 3 hours with 15 minutes time interval and (b) *J*-*V* plot of $TiO_2$-CdTe-N3 based DSSC under 50 mW $cm^{-2}$ for 3 hours with 15 minutes time interval.

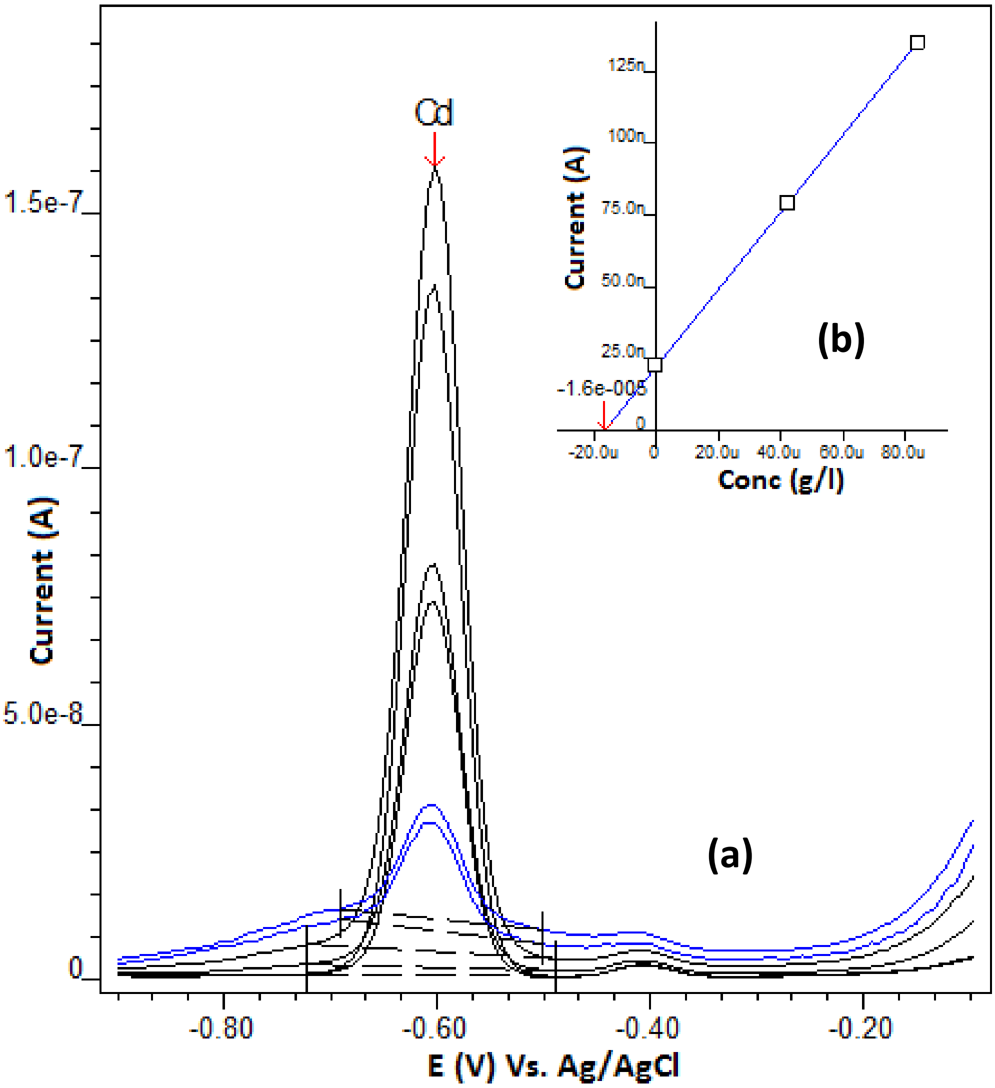


**Fig. S8. (a)** Anodic stripping voltammogram of Cd of $TiO_2$-CdTe (30cycle) matrix.(b) Current Vs. Concentration (ppm) of CdTe (30cycle) coated $TiO_2$ matrix in $NaClO_4$ aqueous electrolyte following potentiodynamic polarization study.

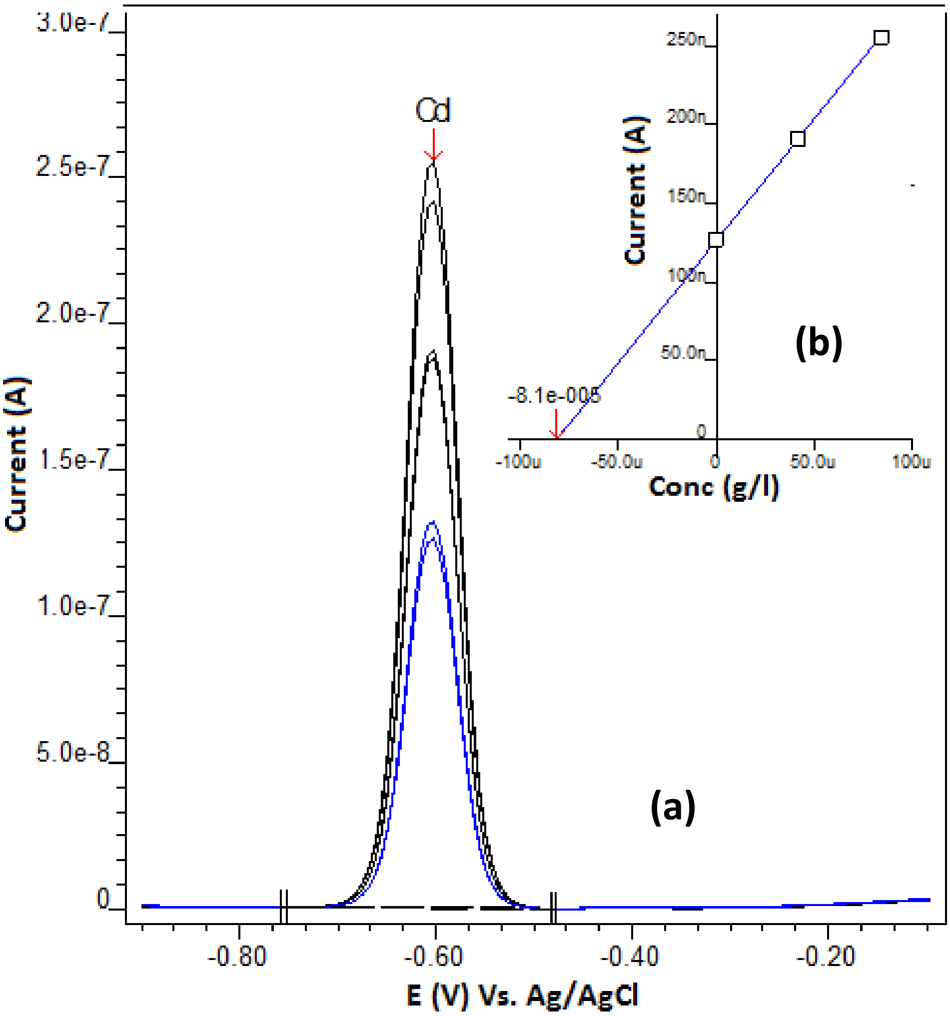
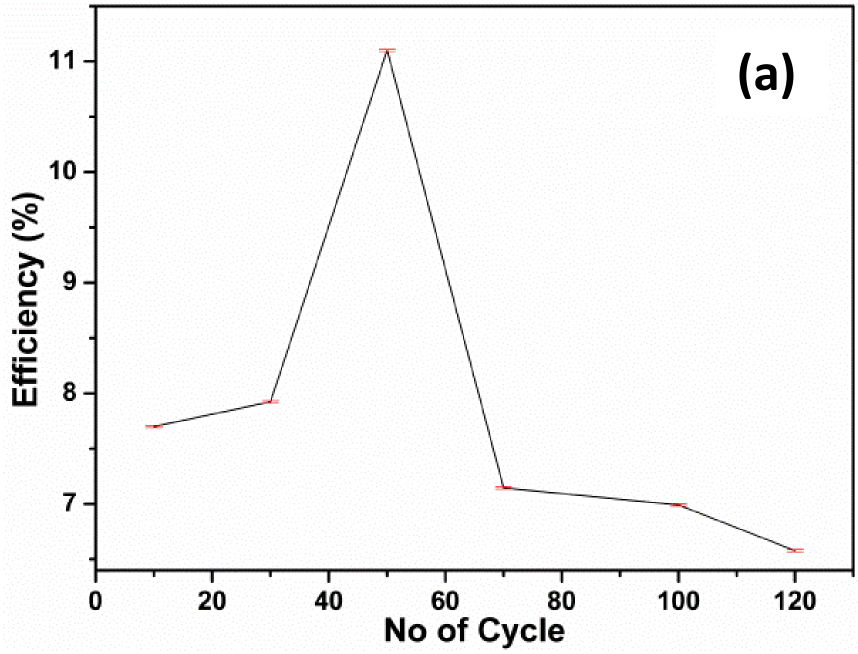
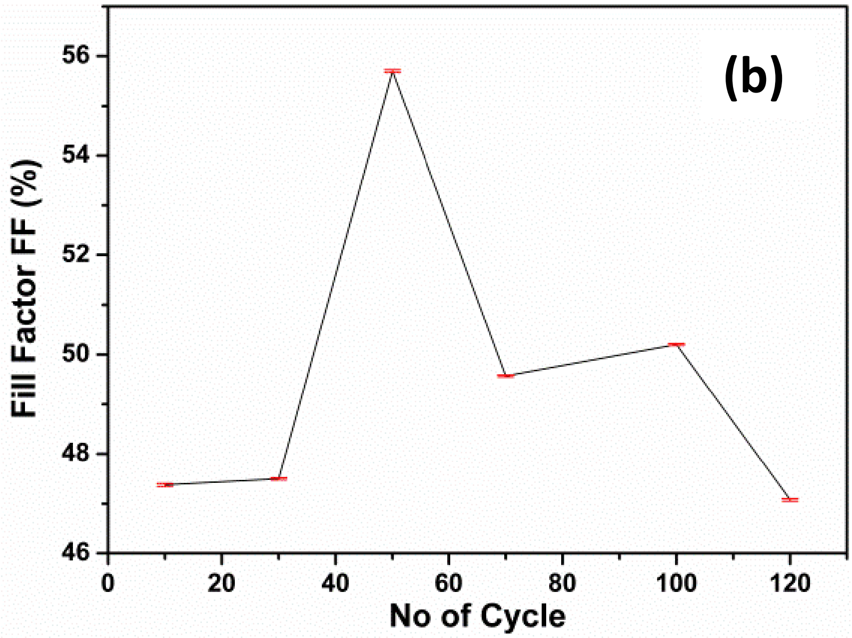


**Fig. S9. (a)** Anodic stripping voltammogram of Cd of $TiO_2$-CdTe (70cycle) matrix.(b) Current Vs. Concentration (ppm) of CdTe (70cycle) coated $TiO_2$ matrix in $NaClO_4$ aqueous electrolyte following potentiodynamic polarization study.


(a)
Efficiency (%)
11
10
9
8
7
0
20
40
60
80
100
120
No of Cycle


(b)
Fill Factor FF (%)
56
54
52
50
48
46
0
20
40
60
80
100
120
No of Cycle

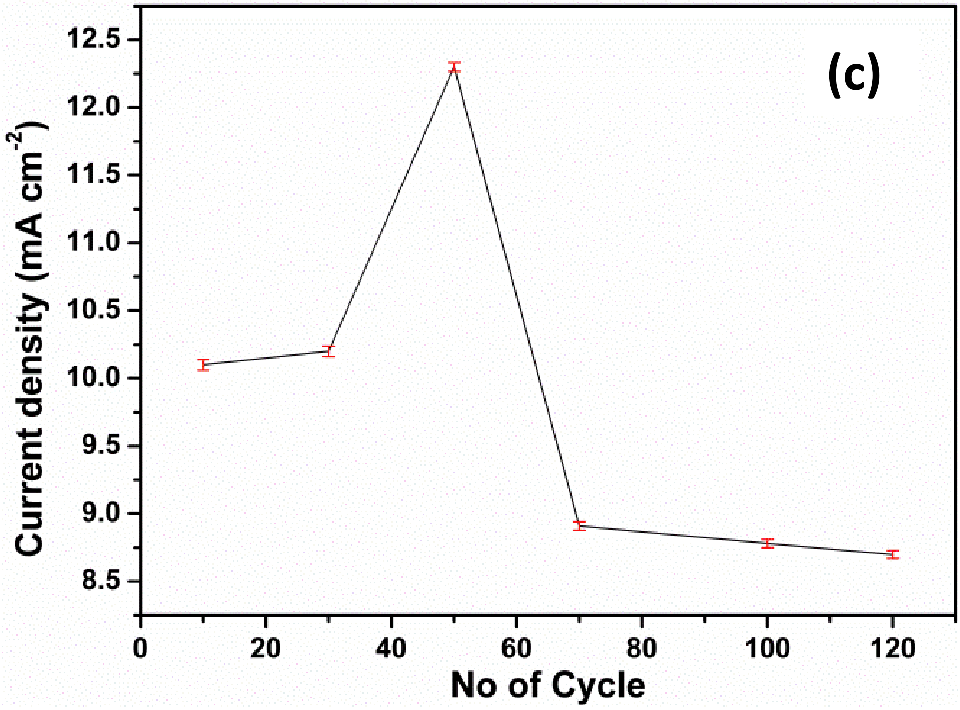


**Fig. S10.** Periodic Cycles vs. (a) Efficiency (b) fill factor FF% and (c) short circuit current density *J*sc, values derived for the DSSC showing mean deviation from four experimental results.