Supporting Information

Dual Function of Molybdenum Sulfide/C-cloth in Enhancing the Performance of Fullerene Nanosheets based Solar cell and Supercapacitor

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Figure S1. Cyclic voltammograms of (a) TiO$_2$/FTO and (b) CdS/FTO recorded in a 0.1 M KOH solution at a scan rate of 10 mV s$^{-1}$ and used as working electrode in three electrode electrochemical cells. Ag/AgCl/KCl is used as reference electrode and a Pt rod as the counter electrode.

The CV plots of TiO$_2$ and CdS shows a reduction potential peaks at $-0.52$ V and $-0.7$ V (verses Ag/AgCl/KCl) in their cathodic sweep. The potential of Ag/AgCl/KCl (verses NHE) is 0.197 V. The reduction potential of TiO$_2$ (verses NHE) is $E_{\text{red}}^{0} = (-0.52 + 0.197)\text{ V} = -0.323\text{ V}$ and reduction potential of CdS (verses NHE) $E_{\text{red}}^{0} = (-0.7 + 0.197)\text{ V} = -0.503\text{ V}$. Therefore, the conduction band (CB) or LUMO of TiO$_2$ (w.r.t vacuum level) is calculated to be $E_{\text{red}}^{0} = -4.5 - (-0.323) = -4.17$ eV and for CdS it is $E_{\text{red}}^{0} = -4.5 - (-0.503) = -4$ eV respectively. By subtracting the optical band gap energy ($E_g$) from CB, the valence
band energy (VB) or HOMO of TiO$_2$ is found to be (-4.17 – 3.19)= -7.36 eV and for CdS it is found to be (-4 – 2.25)= -6.25 eV. These values are used in energy band diagram shown in figure 3e.

![Raman spectra of C-cloth and MoS$_2$/C-cloth and (b) XRD patterns of C-cloth and MoS$_2$.](image)

**Figure S2.** Raman spectra of C-cloth and MoS$_2$/C-cloth and (b) XRD patterns of C-cloth and MoS$_2$.

**Table S1.** Emission decay fitting parameters of photoactive films.

| Sample          | $B_1$  | $\tau_1$ (ns) | $B_2$  | $\tau_2$ (ns) | $\tau$ (ns) | $\chi^2$ |
|-----------------|--------|---------------|--------|---------------|-------------|---------|
| Glass/CdS       | 99.3   | 0.007         | 0.7    | 18.1          | 17.07       | 1.9     |
| FTO/CdS         | 41.32  | 13.1          | 58.68  | 0.084         | 12.98       | 0.96    |
| TiO$_2$/CdS     | 63.98  | 0.218         | 36.02  | 7.12          | 6.764       | 1.03    |
| TiO$_2$/C$_{60}$-B/CdS | 81.82  | 0.074         | 18.18  | 1.65          | 1.385       | 1.04    |
| TiO$_2$/C$_{60}$-NS/CdS | 10.99  | 0.003         | 89.01  | 0.65          | 0.65        | 1.27    |

**Table S2.** Raman data of counter electrodes.

| Counter electrode | D-band (cm$^{-1}$) | G-band (cm$^{-1}$) | $I_D/I_G$ |
|-------------------|--------------------|--------------------|-----------|
| C-cloth           | 1335               | 1584               | 1.16      |
| MoS$_2$/C-cloth   | 1339               | 1586               | 1.025     |
Table S3. EIS parameters for counter electrode based cells in symmetric configurations.

| Counter       | $R_s$ (Ω) | $R_{ct}$ (Ω) | $R_{gb}$ (Ω) |
|---------------|-----------|--------------|--------------|
| C-cloth       | 20.1      | 4            | 14.2         |
| MoS$_2$/C-cloth | 23.6     | 1.4          | 19.2         |

Table S4. Solar cell parameters of large area QDSCs (1 cm$^2$) containing 1 M Na$_2$S + 1 M S polysulfide based gel electrolyte under 1 sun illumination (AM 1.5, 100 mW cm$^{-2}$).

| Photoanode         | $J_{sc}$ (mA cm$^{-2}$) | $V_{oc}$ (mV) | FF  | $\eta$ (%) |
|---------------------|-------------------------|-------------|-----|------------|
| TiO$_2$/CdS         | 1                       | 5.9         | 675 | 0.49       | 2            |
|                     | 2                       | 5.95        | 680.4 | 0.49   | 2            |
| TiO$_2$/CdS-B/CdS   | 1                       | 7.2         | 692.2 | 0.50   | 2.5          |
|                     | 2                       | 7.1         | 709   | 0.47    | 2.4          |
| TiO$_2$/CdS-NS/CdS  | 1                       | 8           | 717.3 | 0.51   | 2.9          |
|                     | 2                       | 8.2         | 719.1 | 0.50   | 3            |

Table S5. Solar cell parameters of TiO$_2$/CdS cell with MoS$_2$/C-cloth counter in polysulfide gel electrolyte under 1 sun illumination at different interval of time.

| Illumination time (min) | $J_{sc}$ (mA cm$^{-2}$) | $V_{oc}$ (mV) | FF  | $\eta$ (%) |
|-------------------------|-------------------------|-------------|-----|------------|
| 0                       | 15.5                    | 741.1       | 0.46 | 5.3        |
| 100                     | 12.9                    | 746.0       | 0.53 | 5.1        |
| 200                     | 12.5                    | 765.5       | 0.54 | 5.2        |
| 300                     | 11.5                    | 804.6       | 0.54 | 5.0        |
| 400                     | 11.0                    | 802.1       | 0.52 | 4.6        |
| 500                     | 10.9                    | 785.0       | 0.51 | 4.3        |