Supplementary Information (SI) for Journal of Materials Chemistry C.


# Greatly Improved the Efficiency and Stability of Planar Perovskite Solar Cells by BDADI Interfacial Modification

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**Table S1** Peak value of O 1s XPS in $SnO_2$ and $SnO_2$-BDADI films.

| | | | | |
|---|---|---|---|---|
| $SnO_2$ | position(eV) | 530.60 | | 531.75 |
| | area ratio | 77.53% | | 22.47% |
| $SnO_2$-BDADI | position(eV) | 530.60 | 531.80 | 532.90 |
| | area ratio | 75.66% | 15.00% | 9.34% |

**Table S2** Peak value of Sn $3d_{5/2}$ XPS in $SnO_2$ and $SnO_2$-BDADI films.

| | | | |
|---|---|---|---|
| $SnO_2$ | position(eV) | 486.83 | 495.02 |
| | area ratio | 59.61% | 40.39% |
| $SnO_2$-BDADI | position(eV) | 486.95 | 495.14 |
| | area ratio | 58.95% | 41.05% |

**Table S3** The biexponential fitted parameters of the TRPL spectra of perovskite films deposited on $SnO_2$ $SnO_2$-BDADI films and their corresponding proportions.

| Sample | $\tau_{ave}$(ns) | $\tau_1$(ns) | $A_1$(%) | $\tau_2$(ns) | $A_2$(%) |
|---|---|---|---|---|---|
| Glass/Perovskite | 460.95 | 512.54 | 89.12 | 38.46 | 10.88 |
| Glass/$SnO_2$/Perovskite | 91.20 | 118.82 | 79.73 | 56.10 | 31.21 |
| Glass/$SnO_2$-BDADI/Perovskite | 88.92 | 100.13 | 42.23 | 67.06 | 57.77 |

$$y(t) = y_0 + A_1 exp(-\frac{t}{\tau_1}) + A_2 exp(-\frac{t}{\tau_2})$$

$$\tau_{ave} = (A_1\tau_1^2 + A_2\tau_2^2)/(A_1\tau_1 + A_2\tau_2)$$

where $A_i$ is relative decay amplitudes and $\tau_i$ is PL decay lifetimes that relate with different influence factors.

**Table S4** Parameters employed for the fitting of the impedance spectra of devices based on $SnO_2$ and $SnO_2$-BDADI ETLs.

| Device | Rs(Ω) | Rct(Ω) | Rrec(Ω) |
|---|---|---|---|
| $SnO_2$ | 15.82 | 6379 | 4191 |
| $SnO_2$-BDADI | 11.1 | 1974 | 6981 |

**Table S5** The photovoltaic parameters of best-performing PSCs based $SnO_2$ and $SnO_2$-BDADI.

| PSCs | Scan direction | $V_{oc}$ (V) | $J_{sc}$ (mA cm$^{-2}$) | FF (%) | PCE (%) |
|---|---|---|---|---|---|
| $SnO_2$ | reverse | 1.07 | 24.22 | 78.15 | 20.25 |
| | forward | 1.05 | 23.78 | 76.56 | 18.09 |
| $SnO_2$-BDADI | reverse | 1.12 | 24.95 | 79.37 | 22.17 |
| | forward | 1.11 | 24.52 | 78.22 | 21.28 |

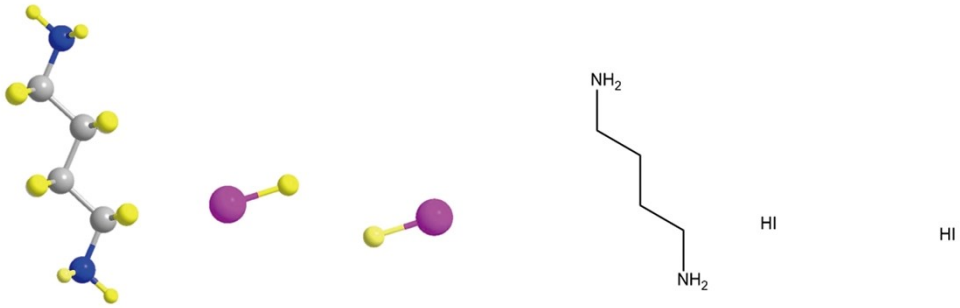


**Fig. S1.** The chemical structure of BDADI .

The specific dissolution equations for the generation of 1, 4-butanediamine cation ($C_4H_{12}N_2^{2+}$) and iodide anion ($I^-$) are as follows:

$$C_4H_{14}N_2I_2(\text{Solid})\underline{DMSO}\ C_4H_{12}N^{2}{}_{2}^{+}(DMSO)_{+2}I^{-}(DMSO)$$

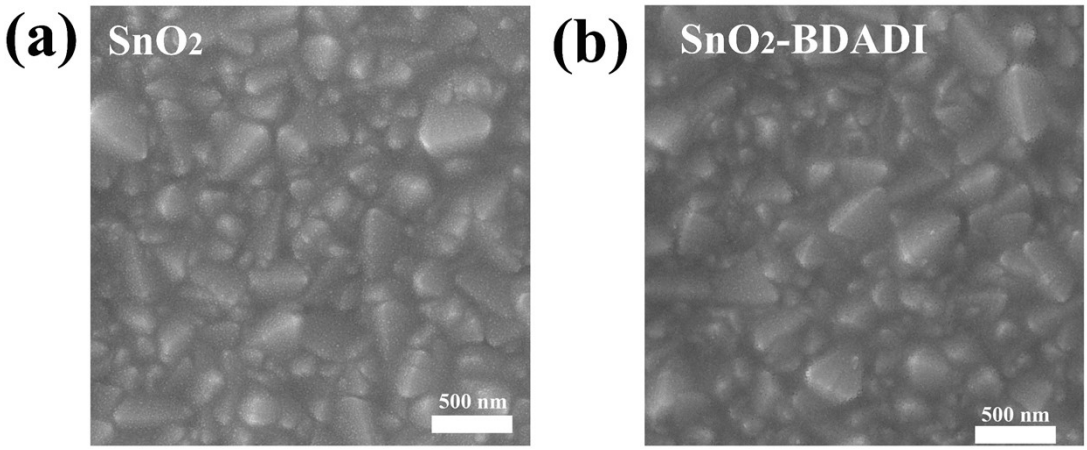


**Fig. S2.** The SEM images of SnO2 film and SnO2-BDADI film.

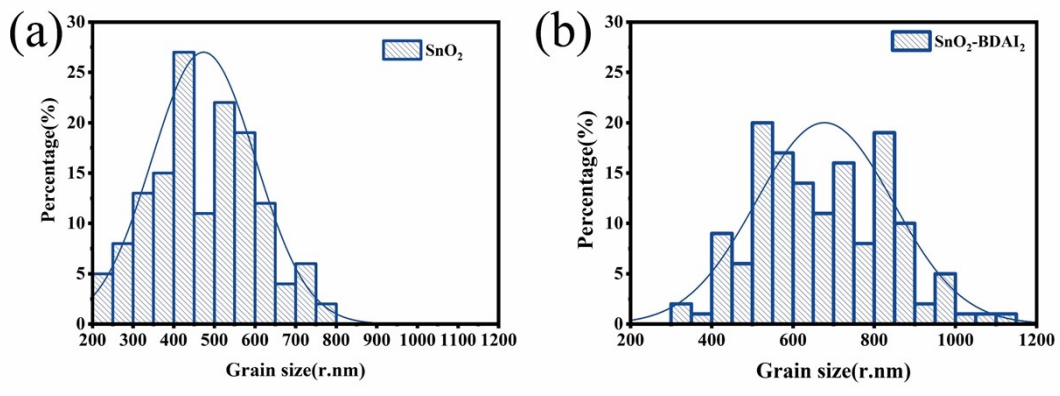


**Fig. S3.** Distribution of perovskite films deposited on (c) $SnO_2$ and (d) $SnO_2$-BDADI film.

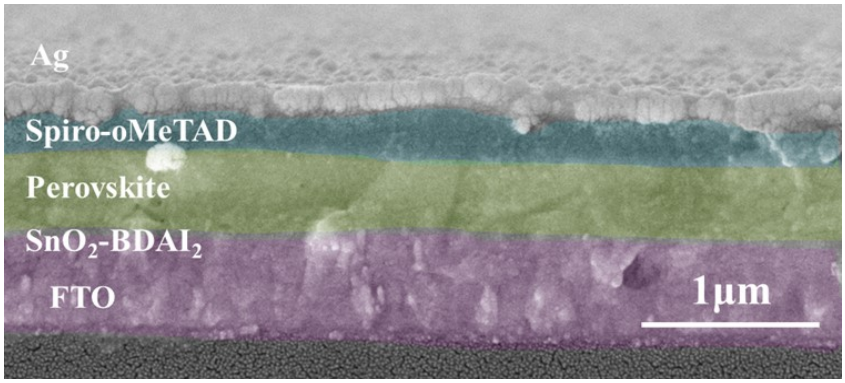


**Fig. S4.** Cross-sectional SEM image of the device with a structure of FTO/$SnO_2$-BDADI/perovskite/Spiro-OMeTAD/Ag.

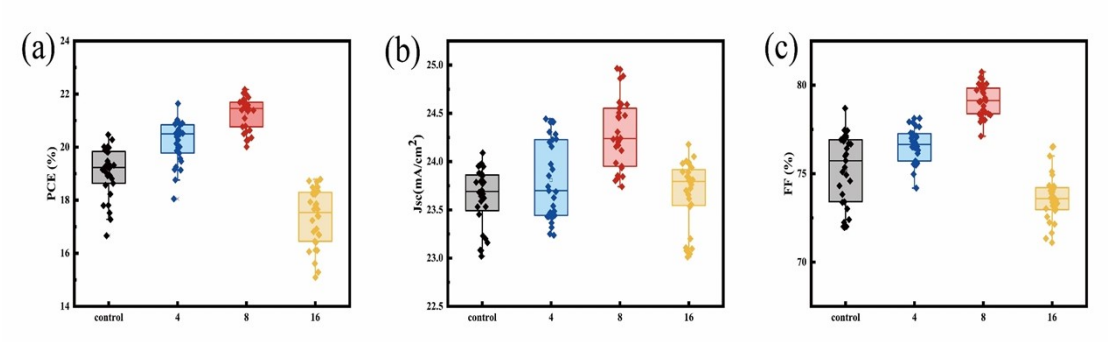


**Fig. S5.** Statistical photovoltaic parameters of PCE (a), Jsc (b), FF (c) and for PSCs based on $SnO_2$ and $SnO_2$-BDADI ETLs.

## Reference


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