

Supporting Information

Well-Organized Mesoporous TiO₂ Photoanode by Using Amphiphilic Graft Copolymer for Efficient Perovskite Solar Cells

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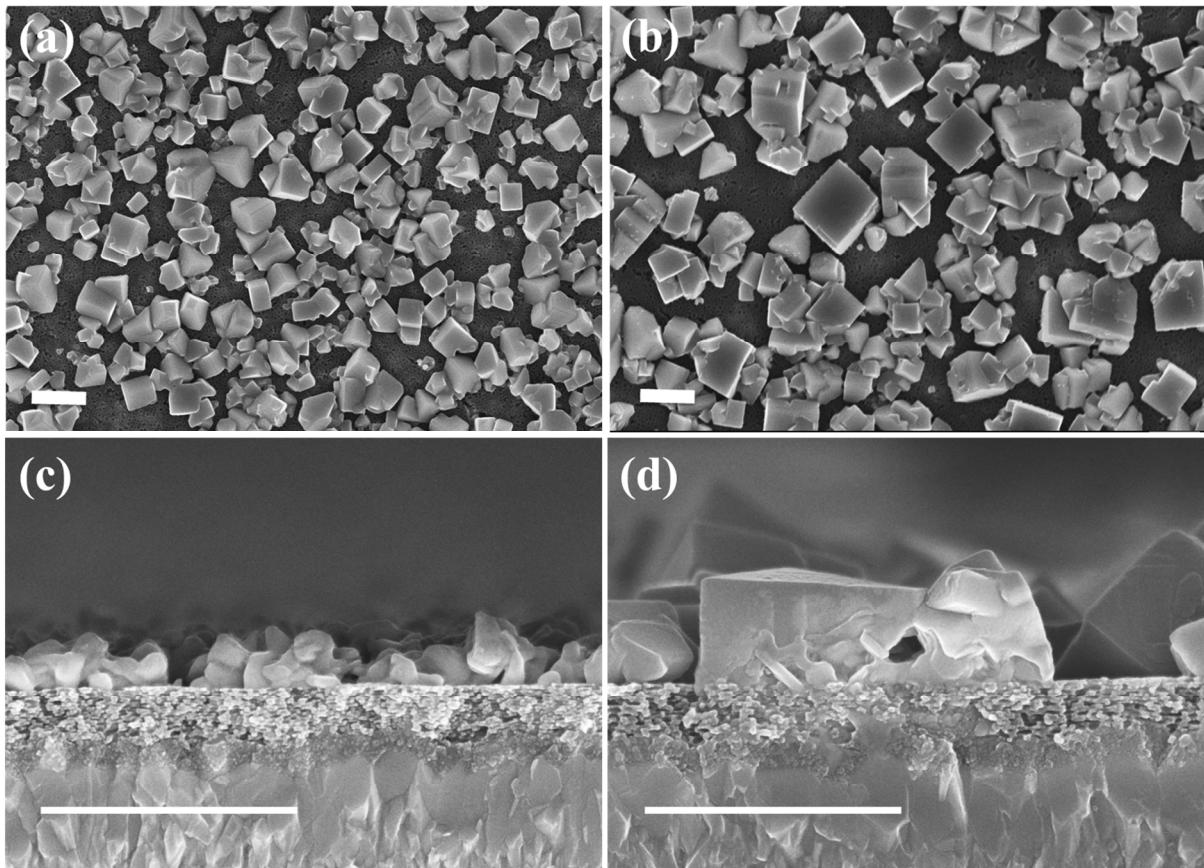


Figure S1. Top-view SEM images of perovskite crystals generated (a) without (PSK) and (b) with (PSK*) the pre-wetting treatment; (c) and (d) show side-view SEM images of PSK and PSK* deposited on the om-TiO₂ layer, respectively. Scale bars represent 1 μm for all images.

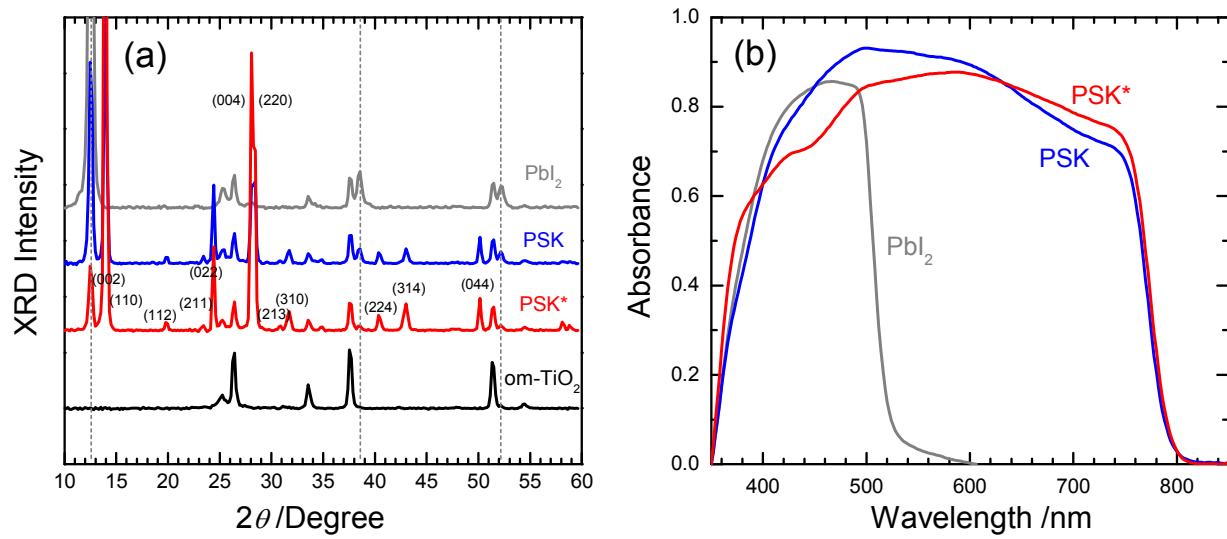


Figure S2. (a) XRD patterns of om-TiO₂ (pore size 70 nm and film thickness 500 nm), PbI₂, PSK (without pre-wetting) and PSK* (with pre-wetting); (b) corresponding absorption spectra of PbI₂, PSK and PSK* substrates. The dotted lines in (a) indicate three major XRD signals of PbI₂.

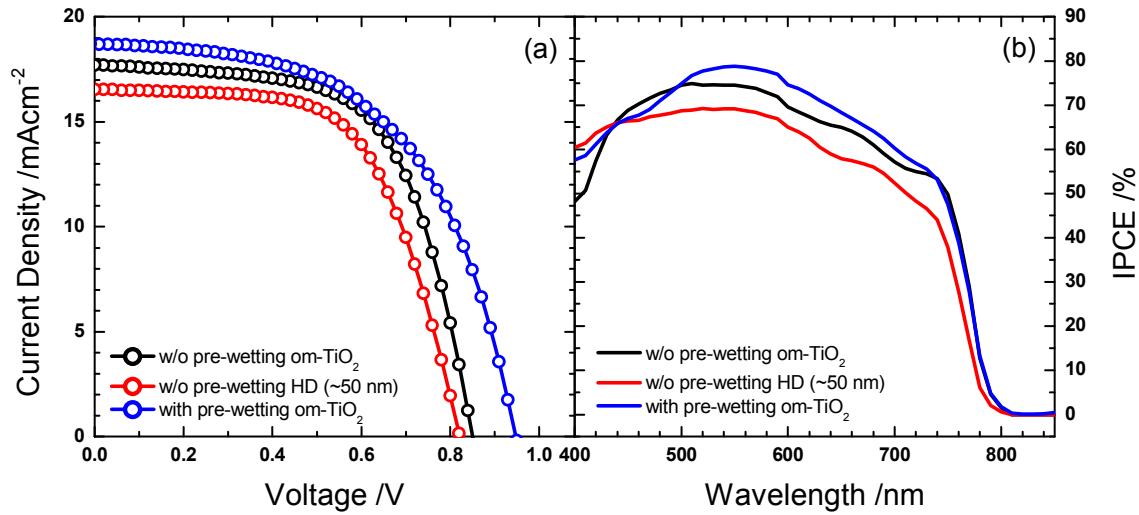


Figure S3. (a) Current-voltage curves and (b) IPCE spectra for om-TiO₂-based and HD-based perovskite solar cells. The pore size for om-TiO₂ is 70 nm; the film thickness is 500 nm.

Table S1. Photovoltaic parameters of mesostructured perovskite solar cells with om-TiO₂-based (pore size 70 nm and film thickness 500 nm) and HD-based (particle size 50 nm and film thickness 500 nm) under simulated AM-1.5G illumination (power density 100 mW cm⁻²) with active area 0.09 cm².

| Devices | J_{sc} /mA cm ⁻² | V_{oc} /mV | FF | PCE /% |
|--|---|------------------------|-------|-----------|
| om-TiO ₂ (no pre-wetting) | 17.70 | 851 | 0.623 | 9.4 |
| HD-TiO ₂ (no pre-wetting) | 16.54 | 822 | 0.617 | 8.4 |
| om-TiO ₂ (with pre-wetting) | 18.66 | 948 | 0.555 | 9.8 |

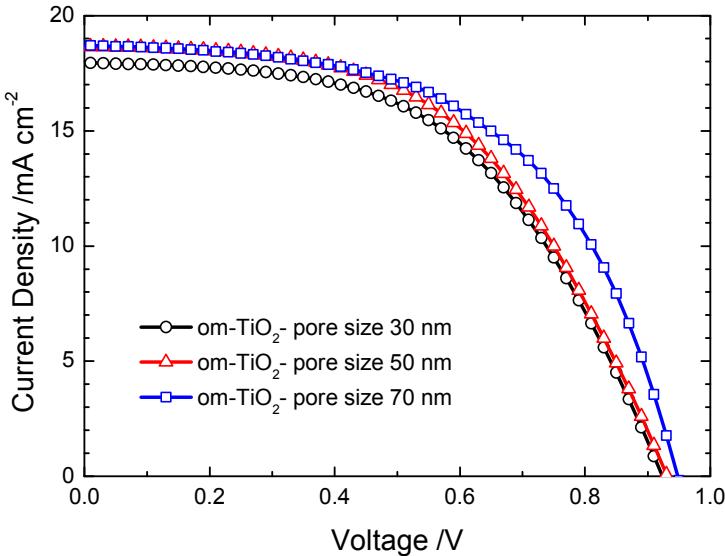


Figure S4. Current-voltage curves for the PSK* devices fabricated with om-TiO₂ layers (thickness 500 nm) of varied pore sizes as indicated.

Table S2. Photovoltaic parameters of the PSK* devices made of om-TiO₂ (film thickness 500 nm) with varied pore size under simulated AM-1.5G illumination (power density 100 mW cm⁻²) with active area 0.09 cm².

| Pore size of om-TiO ₂ /nm | J_{sc} /mA cm ⁻² | V_{oc} /mV | FF | PCE /% |
|---|---|------------------------|-------|-----------|
| 30 | 17.94 | 921 | 0.526 | 8.7 |
| 50 | 18.66 | 932 | 0.522 | 9.1 |
| 70 | 18.71 | 947 | 0.552 | 9.8 |

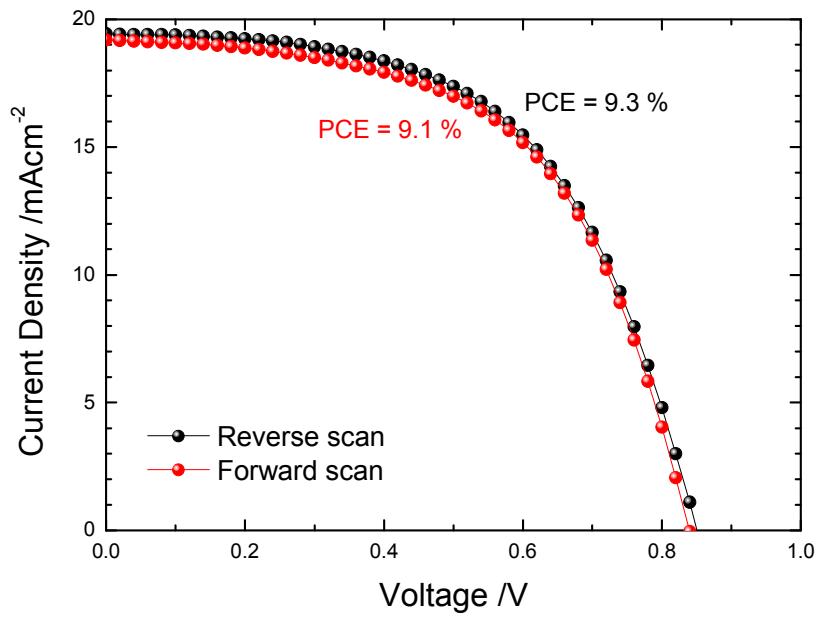


Figure S5. Forward (from short circuit to open circuit) and reverse (from open circuit to short circuit) scans of the current-voltage curves for the PSK* devices fabricated with the om-TiO₂ film thickness 500 nm and pore size 70 nm.

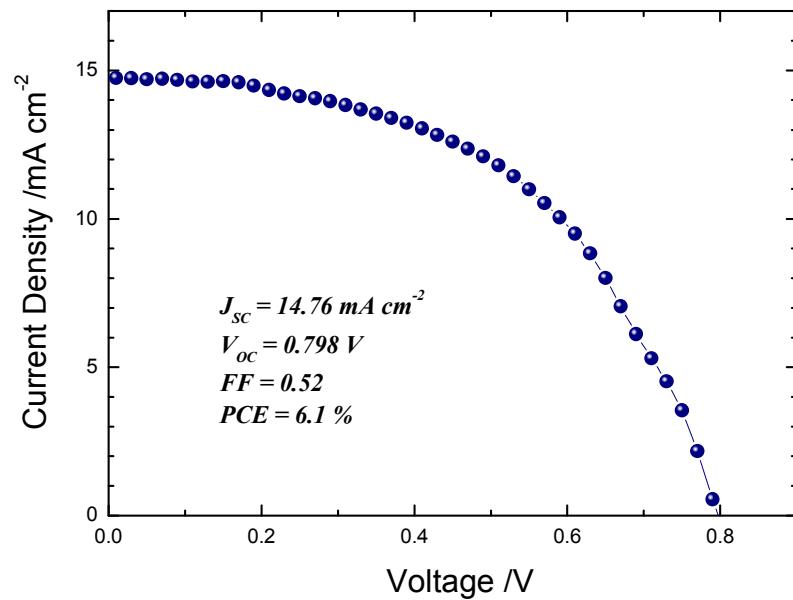


Figure S6. Current-voltage curve of the PSK* devices fabricated with the om-TiO₂ film thickness 150 nm and pore size 70 nm.

Table S3. Photovoltaic parameters of fifteen PSK* devices made of om-TiO₂ (film thickness 300 nm and pore size 70 nm) under simulated AM-1.5G illumination (power density 100 mW cm⁻²) with active area 0.09 cm².

| <i>cell No.</i> | J_{SC} /mA cm ⁻² | V_{OC} /mV | <i>FF</i> | <i>PCE</i> /% |
|-----------------|-------------------------------|--------------|-------------|---------------|
| 1 | 20.21 | 982 | 0.599 | 11.9 |
| 2 | 20.55 | 967 | 0.595 | 11.8 |
| 3 | 20.17 | 994 | 0.582 | 11.7 |
| 4 | 20.50 | 973 | 0.581 | 11.6 |
| 5 | 19.79 | 988 | 0.590 | 11.5 |
| 6 | 20.35 | 979 | 0.572 | 11.4 |
| 7 | 19.69 | 992 | 0.578 | 11.3 |
| 8 | 19.98 | 973 | 0.576 | 11.1 |
| 9 | 20.06 | 971 | 0.567 | 11.1 |
| 10 | 19.30 | 939 | 0.566 | 10.3 |
| 11 | 18.70 | 1022 | 0.533 | 10.2 |
| 12 | 20.60 | 839 | 0.584 | 10.1 |
| 13 | 18.76 | 1015 | 0.534 | 10.2 |
| 14 | 17.72 | 902 | 0.629 | 10.0 |
| 15 | 19.33 | 996 | 0.519 | 10.0 |
| average | 19.71±0.82 | 969±46 | 0.574±0.028 | 11.0±0.7 |

Table S4. Photovoltaic parameters of fifteen PSK* devices made of om-TiO₂ (film thickness 500 nm and pore size 70 nm) under simulated AM-1.5G illumination (power density 100 mW cm⁻²) with active area 0.09 cm²

| <i>cell No.</i> | <i>J_{SC}</i> /mA cm ⁻² | <i>V_{OC}</i> /mV | <i>FF</i> | <i>PCE</i> /% |
|-----------------|--|---------------------------|-------------|---------------|
| 1 | 18.71 | 947 | 0.552 | 9.8 |
| 2 | 18.66 | 948 | 0.555 | 9.8 |
| 3 | 19.98 | 851 | 0.563 | 9.6 |
| 4 | 20.24 | 856 | 0.550 | 9.5 |
| 5 | 19.79 | 955 | 0.504 | 9.5 |
| 6 | 18.65 | 831 | 0.610 | 9.5 |
| 7 | 18.40 | 885 | 0.570 | 9.3 |
| 8 | 18.61 | 915 | 0.532 | 9.1 |
| 9 | 18.64 | 931 | 0.524 | 9.1 |
| 10 | 17.70 | 801 | 0.637 | 9.0 |
| 11 | 17.34 | 855 | 0.598 | 8.9 |
| 12 | 17.66 | 969 | 0.515 | 8.8 |
| 13 | 19.13 | 941 | 0.487 | 8.8 |
| 14 | 19.22 | 854 | 0.527 | 8.7 |
| 15 | 17.96 | 924 | 0.523 | 8.7 |
| average | 18.71±0.86 | 898±53 | 0.550±0.041 | 9.2±0.4 |

Table S5. Photovoltaic parameters of fifteen PSK* devices made of om-TiO₂ (film thickness 800 nm and pore size 70 nm) under simulated AM-1.5G illumination (power density 100 mW cm⁻²) with active area 0.09 cm²

| # of cell | J_{SC} /mA cm ⁻² | V_{OC} /mV | FF | PCE/% |
|-----------|-------------------------------|--------------|-------------|---------|
| 1 | 17.34 | 855 | 0.598 | 8.9 |
| 2 | 17.08 | 808 | 0.638 | 8.8 |
| 3 | 16.75 | 818 | 0.636 | 8.7 |
| 4 | 15.23 | 841 | 0.675 | 8.6 |
| 5 | 18.25 | 950 | 0.495 | 8.6 |
| 6 | 19.23 | 894 | 0.491 | 8.5 |
| 7 | 19.14 | 821 | 0.542 | 8.5 |
| 8 | 18.12 | 748 | 0.628 | 8.5 |
| 9 | 16.61 | 812 | 0.593 | 8.0 |
| 10 | 15.53 | 819 | 0.623 | 7.9 |
| 11 | 18.58 | 924 | 0.462 | 7.9 |
| 12 | 16.64 | 814 | 0.574 | 7.8 |
| 13 | 17.66 | 912 | 0.465 | 7.5 |
| 14 | 18.00 | 793 | 0.520 | 7.4 |
| 15 | 17.24 | 796 | 0.523 | 7.2 |
| average | 17.43±1.18 | 840±56 | 0.564±0.069 | 8.2±0.5 |