Supporting Information

Highly efficient and stable perovskite solar cells via bilateral passivation layers

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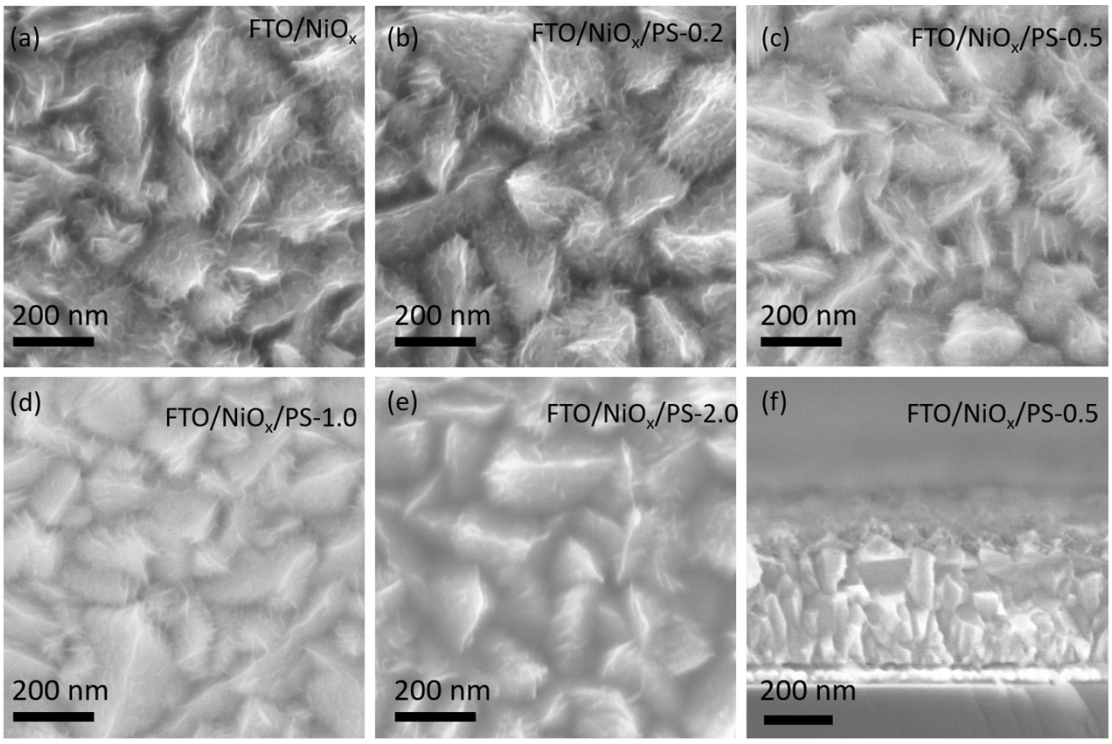

Figure S1. Top-view SEM images of FTO/NiO_x sample deposited with different PS concentrations (mg mL^{-1}) at (a) 0, (b) 0.2, (c) 0.5, (d) 1.0 and (e) 2.0. (f) The cross-sectional SEM image of the FTO/NiO_x sample deposited with PS at the concentration of 0.5 mg mL^{-1}. The numbers in the images represent the PS concentration (mg mL^{-1}) dissolved in chlorobenzene.

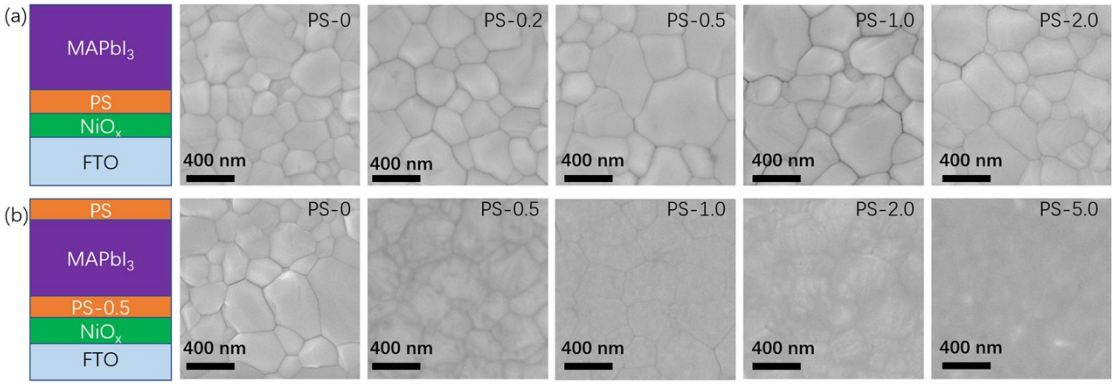

Figure S2. Structure diagrams of three different structures, (a) FTO/NiO_x/PS/$MAPbI_3$ and (b) FTO/NiO_x/PS-0.5/$MAPbI_3$/PS and the corresponding top-view SEM images. (a) Perovskite films depositing on the bottom passivation layer with different PS concentrations from 0 to 2.0 mg mL^{-1}. (b) Perovskite films depositing on the bottom passivation film (PS-0.5) with different PS concentration from 0 to 5.0 mg mL^{-1}, here the PS/CB solution acts as the antisolvent.

Table S1. Photovoltaic parameters of the PSCs based on bottom passivation layer at various concentrations of PS solution.

C_{PS} (mg mL^{-1})	V_{OC} (V)	J_{SC} (mA cm^{-2})	FF (%)	PCE (%)
0	1.050	21.11	71.74	15.90
0.2	1.099	21.12	72.85	16.91
0.5	1.108	22.45	73.94	18.39
1.0	1.092	22.10	74.36	17.95
2.0	1.062	21.22	64.31	14.49

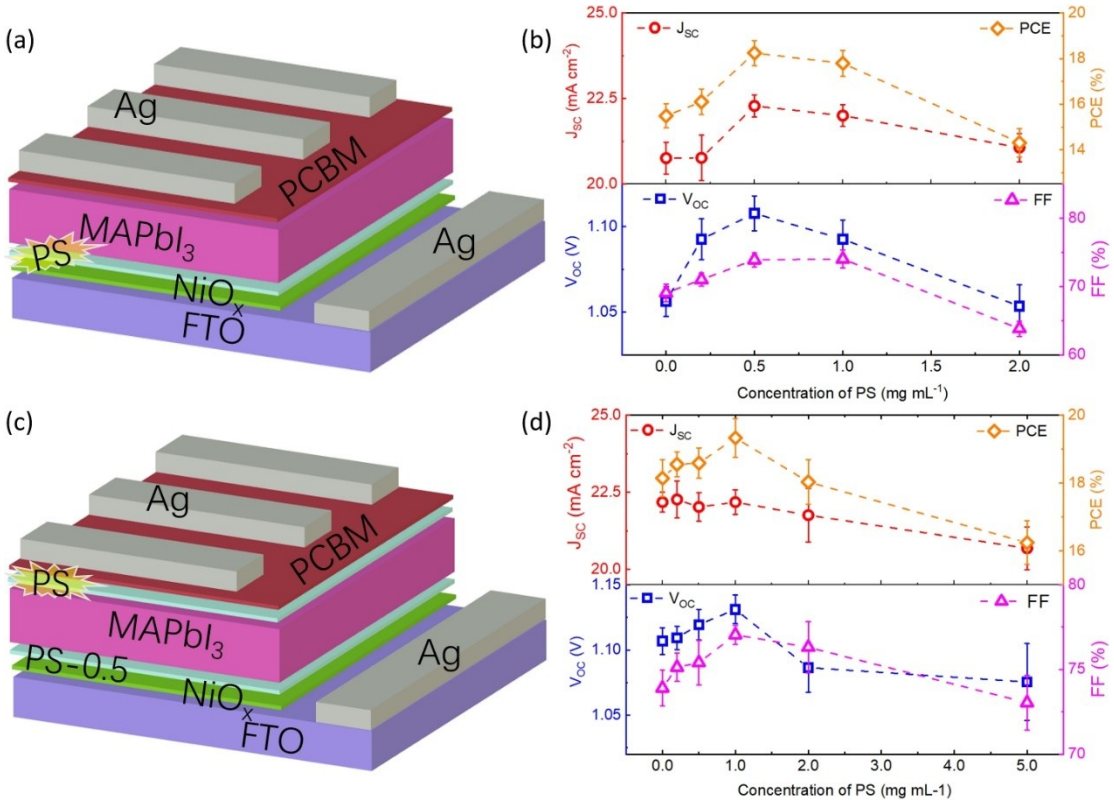

Figure S3. Three-dimensional schematic diagram of the PSC with (a) a bottom passivation layer and (c) bilateral passivation layers. Statistics of V_{OC}, J_{SC}, FF and PCE for (b) bottom and (d) bilaterally passivated PSCs with different PS concentrations.

Table S2. Photovoltaic parameters of the bilaterally passivated PSCs based on bottom passivation of PS-0.5 and various concentrations for preparing top passivation layer.

C_{PS} (mg mL^{-1})	V_{OC} (V)	J_{SC} (mA cm^{-2})	FF (%)	PCE (%)
0	1.108	22.45	73.94	18.39
0.5	1.129	22.51	75.44	19.17
1.0	1.149	22.51	77.33	19.99
2.0	1.104	21.62	78.22	18.67
5.0	1.094	21.09	74.41	17.16

Table S3. Summarization of the open-circuit voltage for various perovskite solar cells.

Device structure	PCE (%)	V_{OC} (V)	Year/Ref.
ITO/NiO_x/MAPbI3/C_{60}/BCP/Ag	18.18	1.09	2018[1]
ITO/NiO_x:rGO/$MAPbI_3$/PCBM/BCP/Ag	18.90	1.07	2019[2]
FTO/PEDOT:PSS/$MAPbI_3$/HBM/Ag	20.60	1.12	2019[3]
FTO/TiO_2/$MAPbI_3$/Spiro-OMeTAD/Au	18.70	1.10	2019[4]
ITO/P3CT-N/$MAPbI_3$/IT-4X/s-Bphen/Ag	17.65	1.08	2019[5]
FTO/Zn:NiO_x/$MAPbI_3$/PCBM/BCP/Ag	18.98	1.08	2019[6]
ITO/PTAA/$MAPbI_3$/C_{60}/BCP/Ag	19.50	1.09	2019[7]
ITO/SnO_2/$MAPbI_3$/Spiro-OMeTAD/P3HT/Au	18.50	1.10	2019[8]
FTO/TiO_2NW/$MAPbI_3$/Spiro-OMeTAD/Au	19.50	1.12	2019[9]
FTO/TiO_2MCP/$MAPbI_3$/Spiro-OMeTAD/Au	20.08	1.09	2019[10]
FTO/TiO2/MAPbI3/Spiro-OMeTAD/Au	18.59	1.11	2019[11]
FTO/NiO_x/PS/$MAPbI_3$/PS/PCBM/Ag	19.99	1.149	Our work

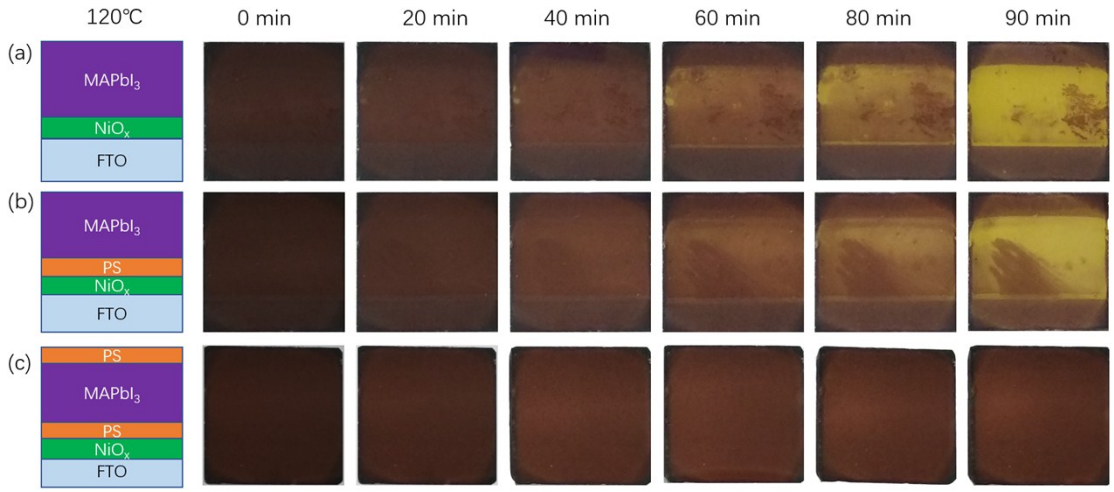

Figure S4. Photographs of (a) the pristine perovskite film without passivation layers

and (b) bottom and (c) bilateral-passivated perovskite films annealed at 120 °C in ambient air (humidity 60%) for different times.

References

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