Supporting Information

Systematical Investigation of Metal Dopants and Mechanism for SnO2 Electron Transport Layer in Perovskite Solar Cells

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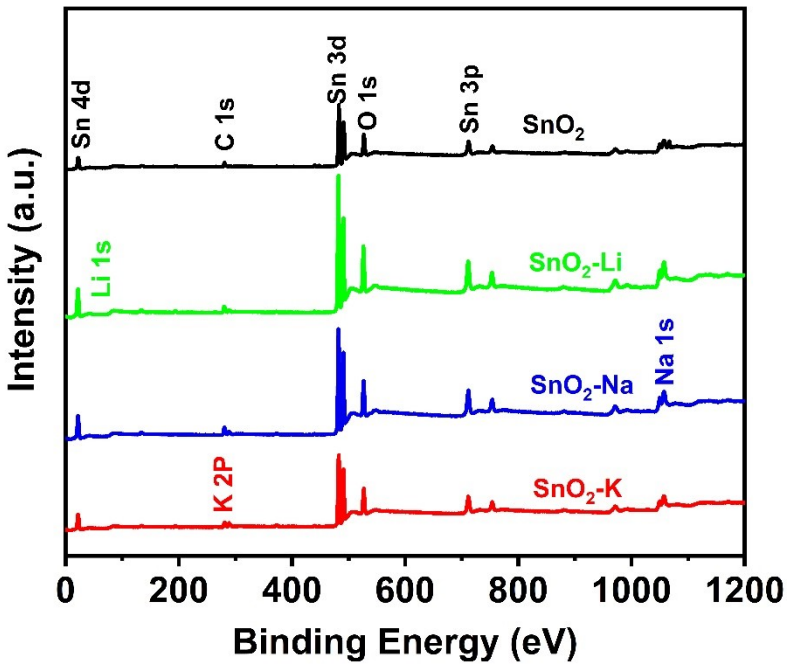

Figure S1 The whole XPS spectra of SnO_2 and SnO_2 with different dopants including Li, Na, K.

Table S1 XRD parameters: full width at half maxima (FWHM) of SnO_2 and SnO_2 with different dopants including Li, Na, K.

Samples	FWHM (110/25.6°)	FWHM (220/51.2°)
SnO_2	0.211	0.269
SnO_2-Li	0.156	0.216
SnO_2-Na	0.123	0.200
SnO_2-K	0.106	0.124

Table S2 XRD parameters: FWHM of the perovskite films on SnO_2 and SnO_2 with different dopants including Li, Na, K.

Samples	FWHM (110/13.4°)	FWHM (310/31.2°)
SnO_2	0.235	0.213
SnO_2-Li	0.218	0.201
SnO_2-Na	0.189	0.174
SnO_2-K	0.164	0.153

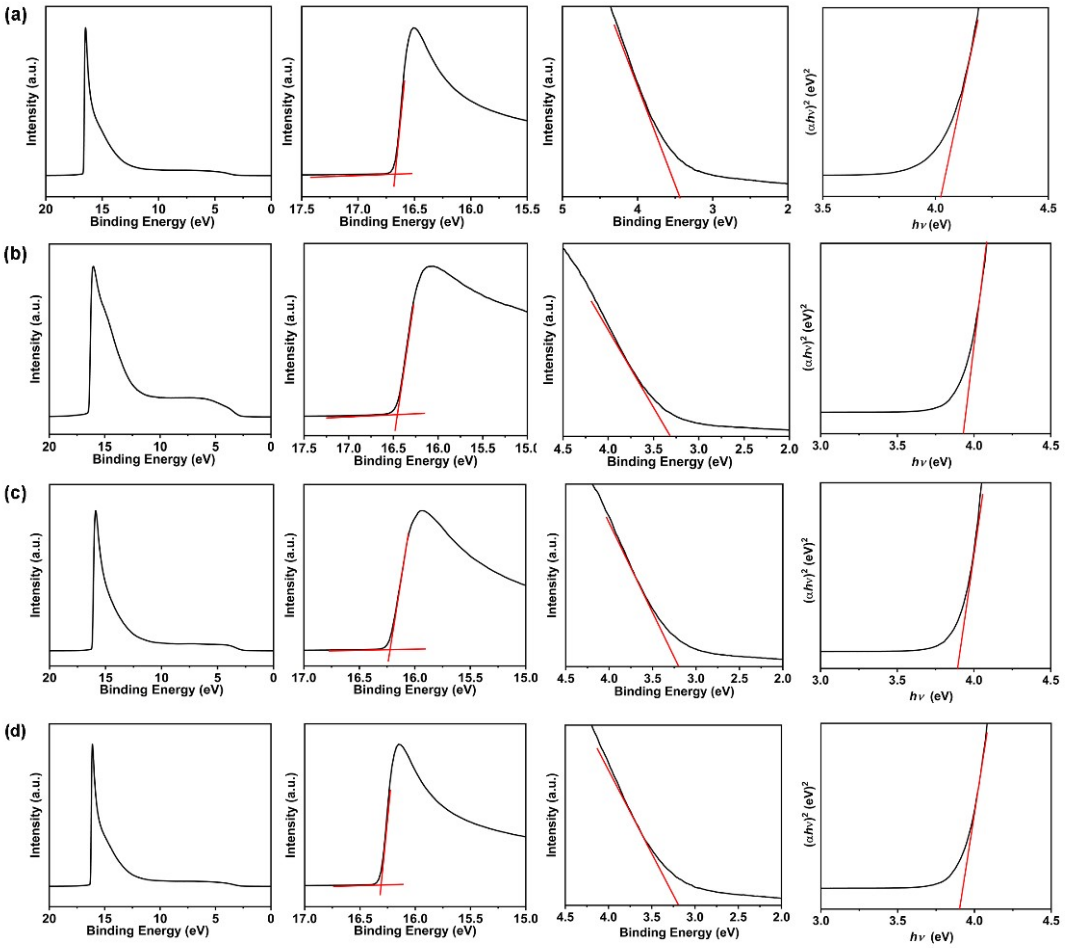

Figure S2 (a) SnO_2 (b) SnO_2-Li (c) SnO_2-Na (d) SnO_2-K. For all the Figure captions a-d, the first images were the whole UPS spectra, the second images were the secondary-electron cut-off, the third images were the valence band region, the fourth images were the Tauc plot curve.

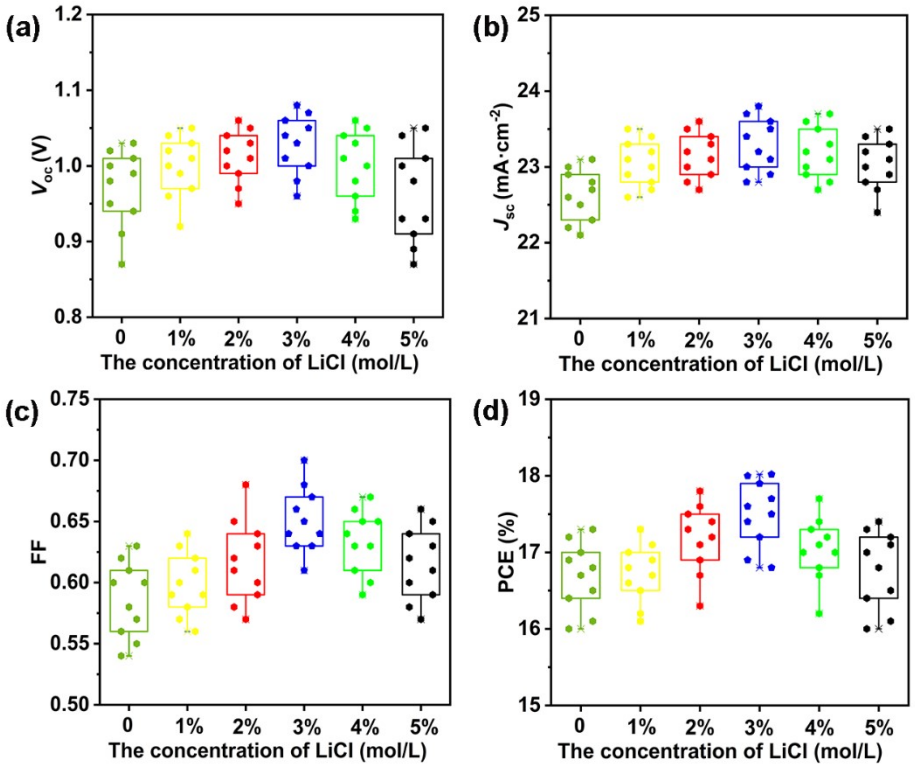

Figure S3 Photovoltaic parameters (V_{oc}, J_{sc}, FF, and PCE) of PSCs at various concentration of LiCl.

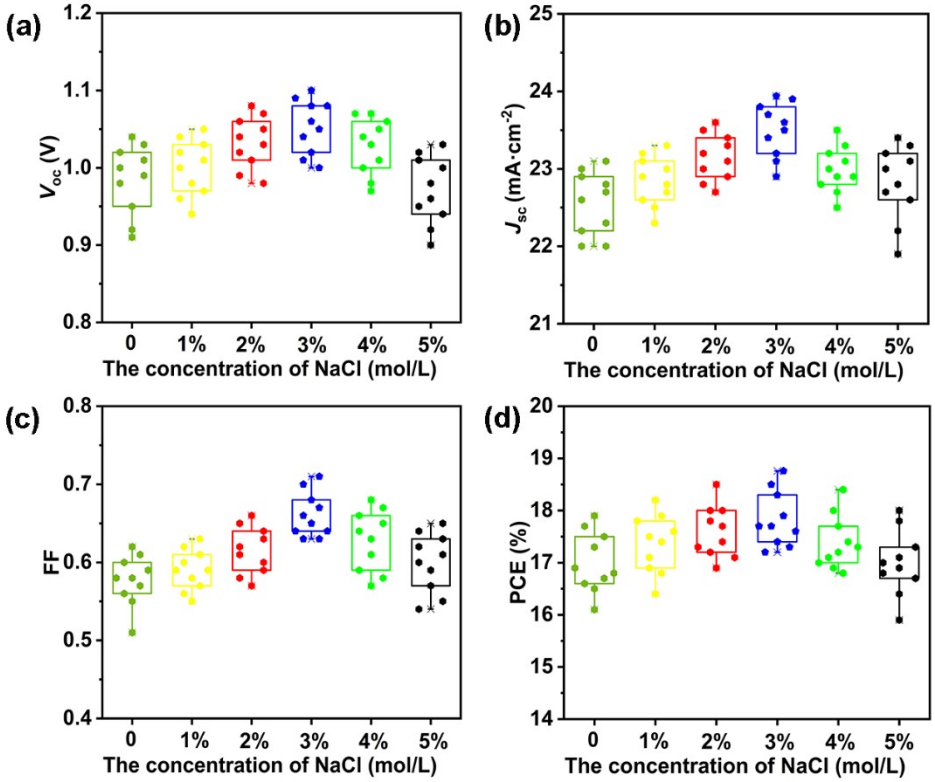

Figure S4 Photovoltaic parameters (V_{oc}, J_{sc}, FF, and PCE) of PSCs at various concentration of NaCl.

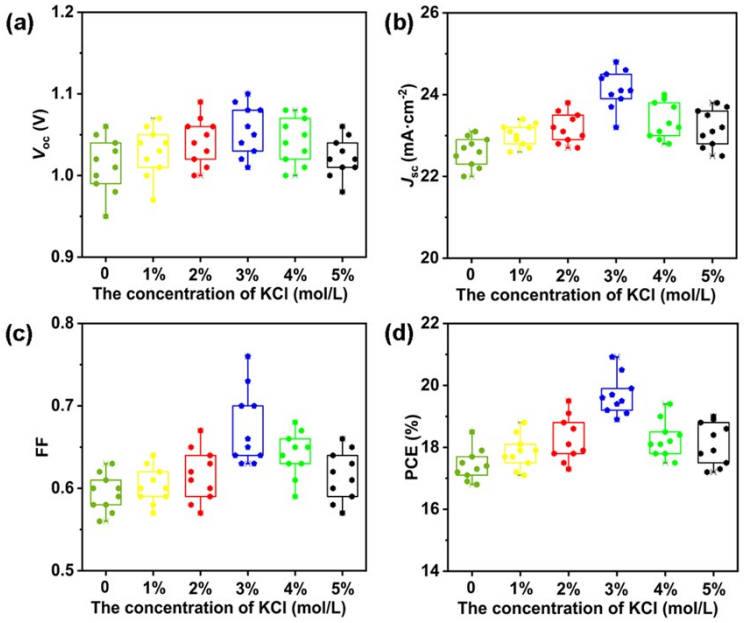

Figure S5 Photovoltaic parameters (V_{oc}, J_{sc}, FF, and PCE) of PSCs at various concentration of KCl.

Table S3 The EIS details of PSCs based on different ETLs: SnO_2 and SnO_2 with different dopants including Li, Na, K.

Samples	R_s/Ω	R_{tr}/Ω	R_{rec}/Ω
SnO_2	20.50	90.90	200.68
SnO_2-Li	15.70	68.70	260.50
SnO_2-Na	14.90	52.70	280.50
SnO_2-K	12.20	47.80	301.70

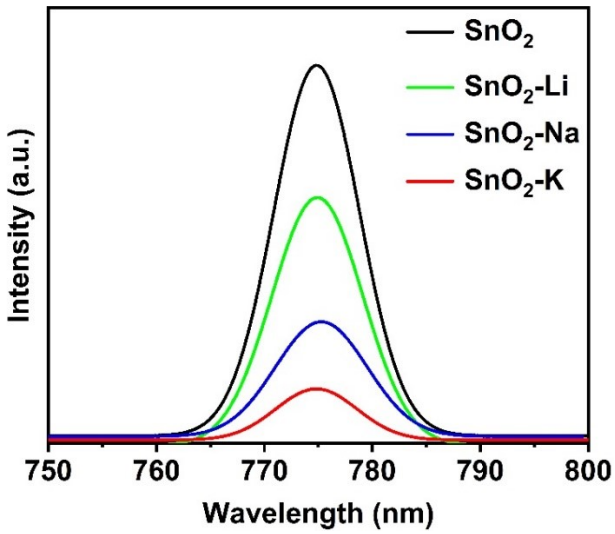

Figure S6 PL spectra tested with FTO/SnO_2/perovskite or FTO/SnO_2-Li, Na, K/perovskite.

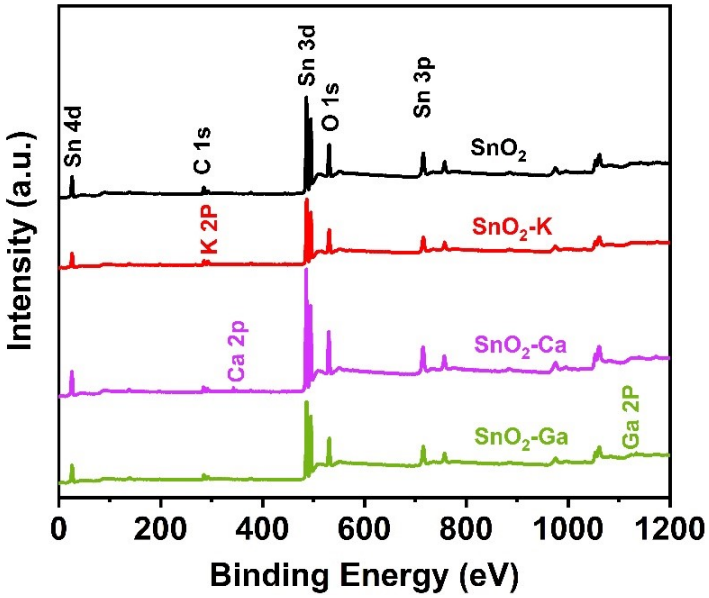

Figure S7 The whole XPS spectra of SnO_2 and SnO_2 with different dopants including K, Ca, Ga.

Table S4 XRD parameters: FWHM of SnO_2 with different dopants including K, Ca, Ga.

Samples	FWHM (110/25.6°)	FWHM (220/51.2°)
SnO_2-K	0.106	0.124
SnO_2-Ca	0.166	0.234
SnO_2-Ga	0.209	0.264

Table S5 XRD parameters: FWHM of the perovskite films on SnO_2 with different dopants including K, Ca, Ga.

Samples	FWHM (110/13.4°)	FWHM (310/31.2°)
SnO_2-K	0.164	0.153
SnO_2-Ca	0.227	0.208
SnO_2-Ga	0.230	0.210

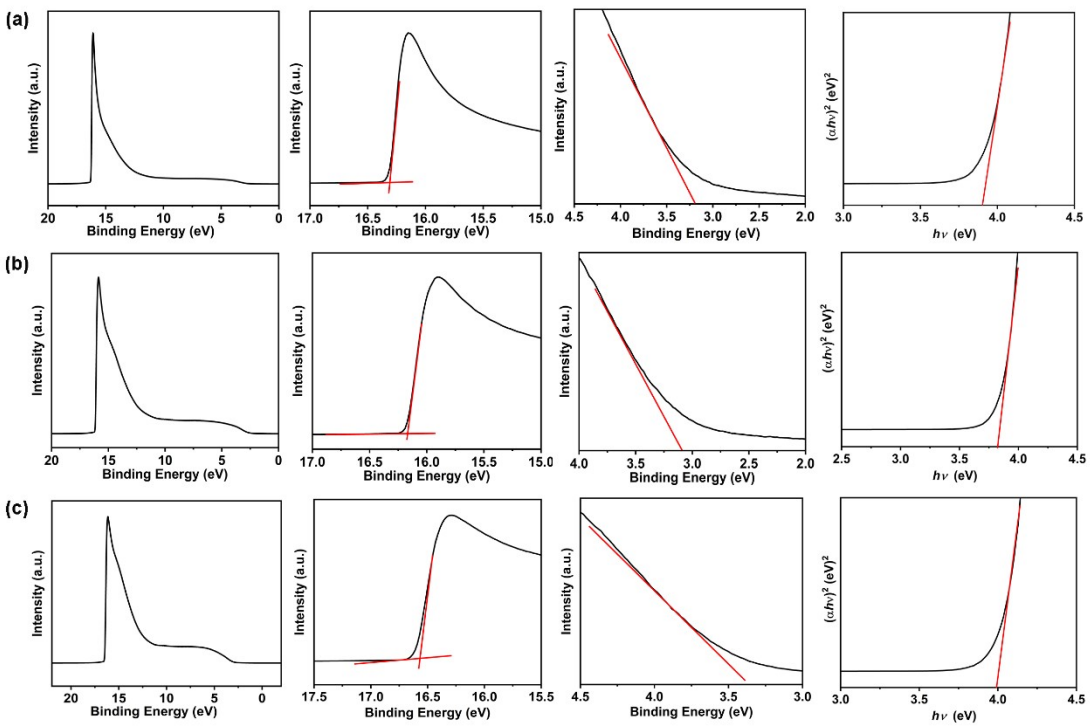

Figure S8 (a) SnO_2-K (b) SnO_2-Ca (c) SnO_2-Ga. For all the Figure captions a-d, the first images were the whole UPS spectra, the second images were the secondary-electron cut-off, the third images were the valence band region, the fourth images were the Tauc plot curve.

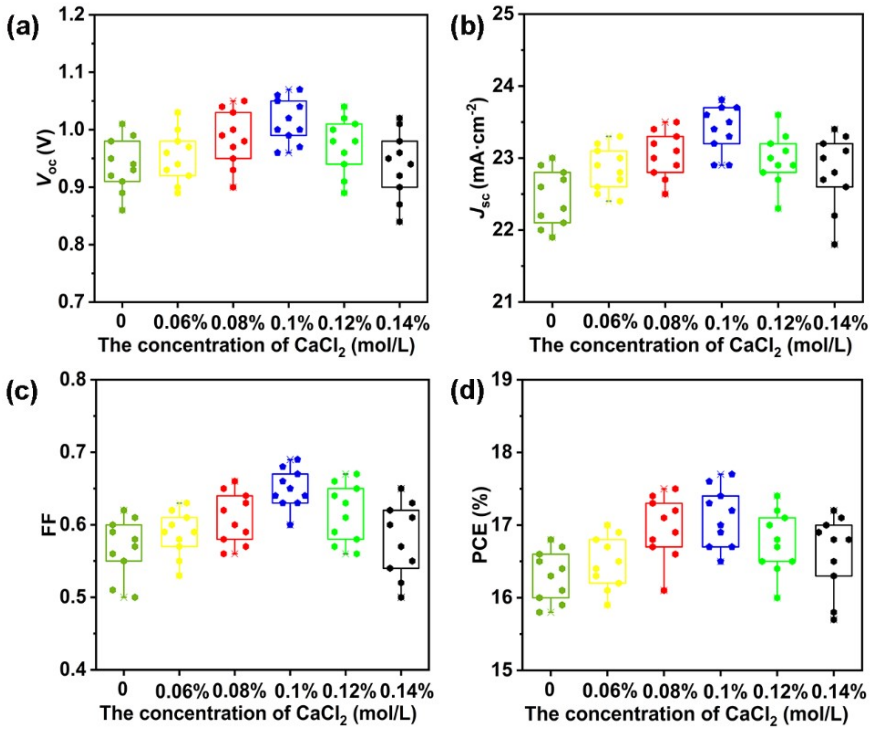

Figure S9 Photovoltaic parameters (V_{oc}, J_{sc}, FF, and PCE) of PSCs at various concentration of $CaCl_2$.

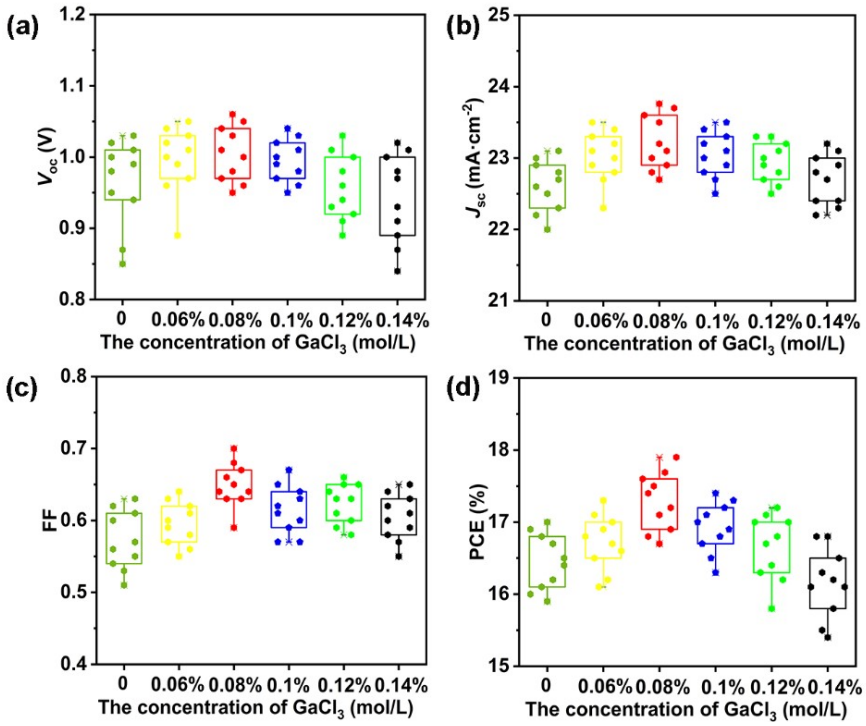

Figure S10 Photovoltaic parameters (V_{oc}, J_{sc}, FF, and PCE) of PSCs at various concentration of $GaCl_3$.

Table S6 The EIS details of PSCs based on different ETLs: SnO_2 and SnO_2 with different dopants including K, Ca, Ga.

Samples	R_s/Ω	R_{tr}/Ω	R_{rec}/Ω
SnO_2-K	12.2	47.8	301.7
SnO_2-Ca	16.3	75.6	244.6
SnO_2-Ga	18.5	81.9	224.6

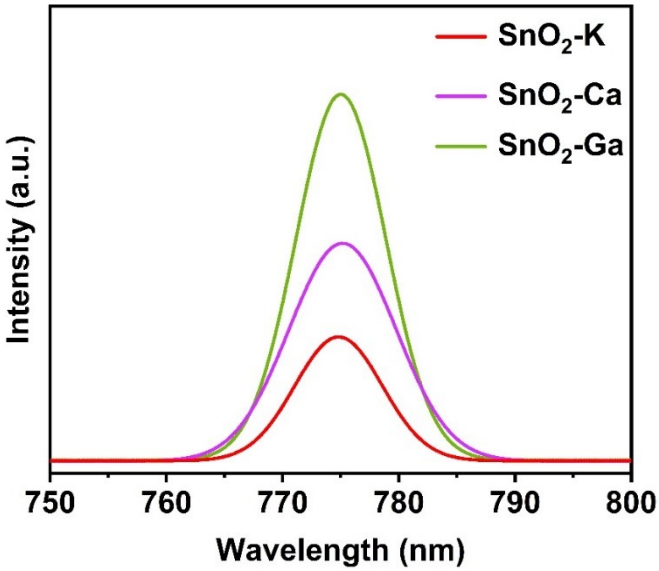

Figure S11 PL spectra tested with FTO/SnO_2/perovskite or FTO/SnO_2-K, Ca, Ga/perovskite.

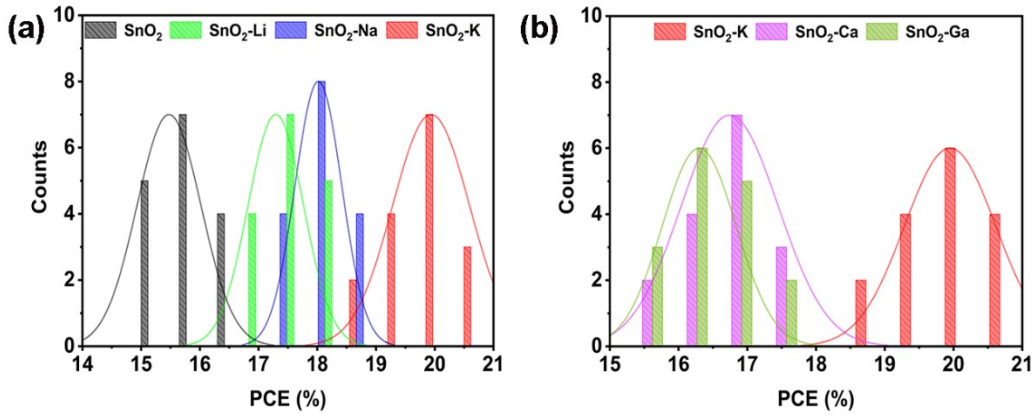

Figure S12 Reproducibility of 16 samples with (a) SnO_2 and SnO_2 with different dopants including Li, Na, K; (b) SnO_2 and SnO_2 with different dopants including K, Ca, Ga.

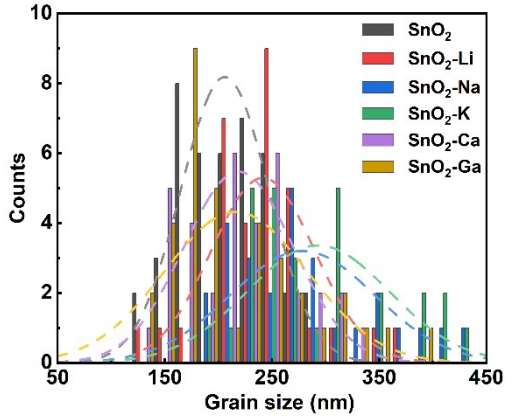

Figure S13 Statistical data of the grain size of the perovskite films based on different SnO_2 films.