Electronic supplementary information

Alkali doping strategy to improve the photovoltaic properties of Ag_2BiI_5 solar cells

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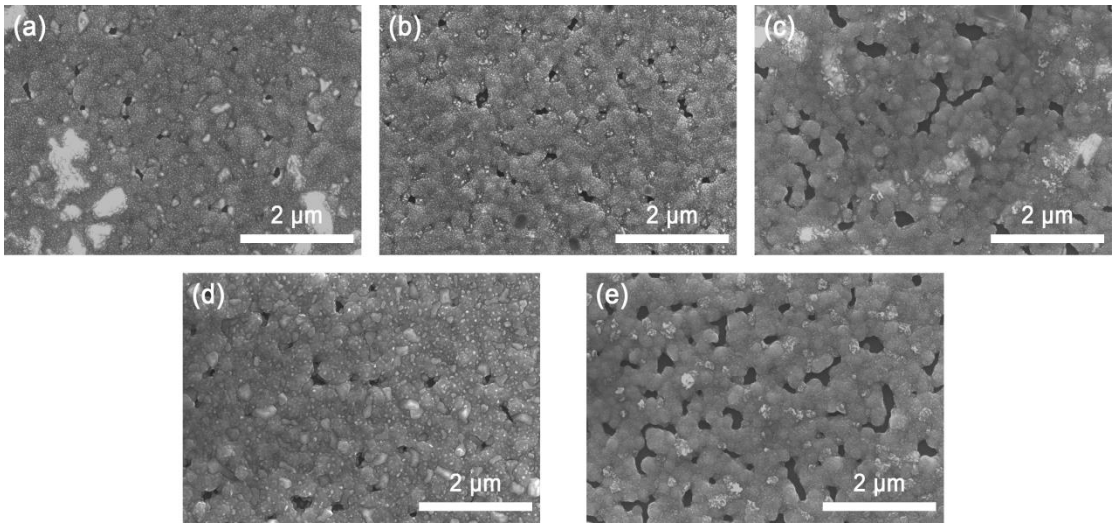

Fig. S1. Top-view SEM images of as-prepared Ag-Bi-S-I films doped with (a) Li^+; (b) Na^+; (c) K^+; (d) Rb^+ and (e) Cs^+.

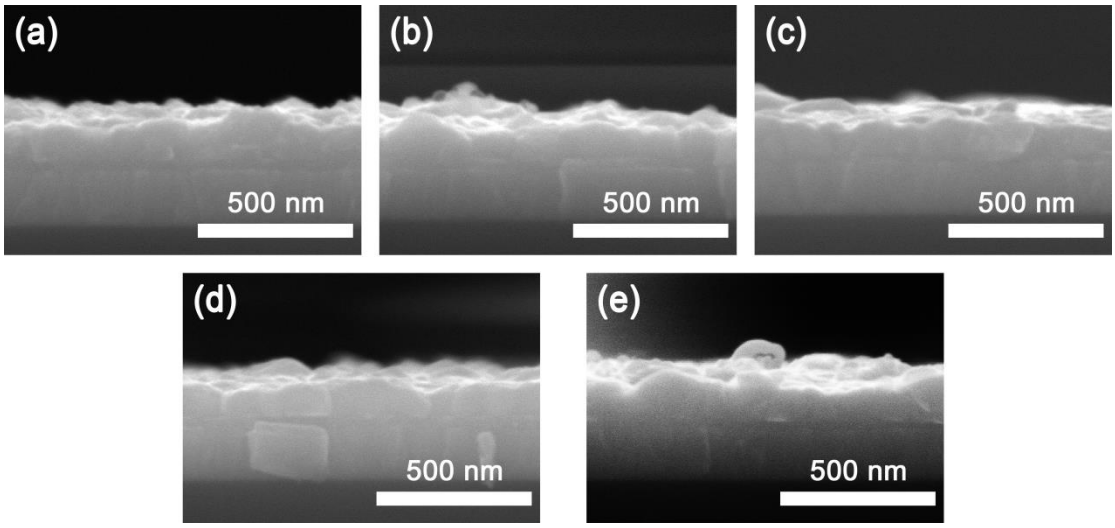

Fig. S2. Cross-sectional SEM images of as-prepared Ag-Bi-S-I films doped with (a) Li^+; (b) Na^+; (c) K^+; (d) Rb^+ and (e) Cs^+.

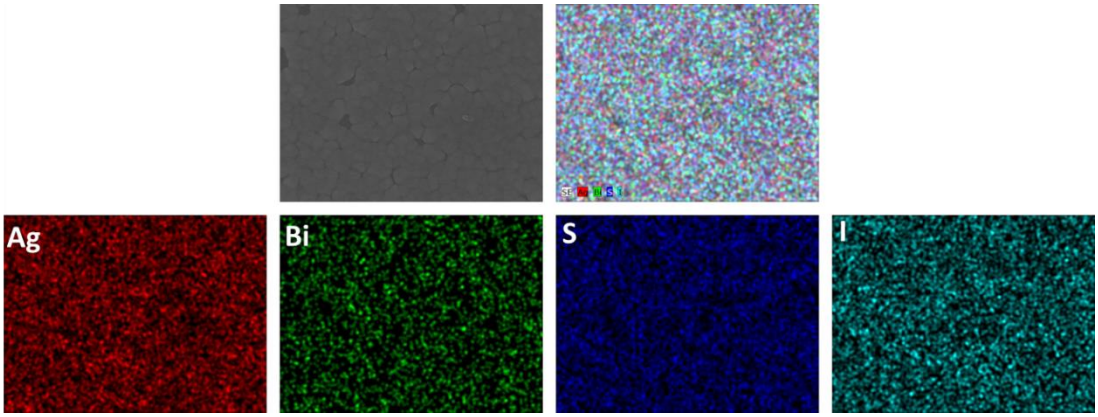

Fig. S3. The energy dispersive spectroscopy (EDS) mapping of as-prepared undoped Ag_2BiI_5 film.

Table S1. The elements contents of the as-prepared Ag_2BiI_5 thin films doped with different alkali ions.

Sample	Ag (at.%)	Bi (at.%)	I (at.%)	alkali (at.%)	alkali/(Ag+Bi) (%)
Ag_2BiI_5	28.38	12.06	59.56	-	-
Ag_2BiI_5:Li	24.75	12.55	61.61	1.09	2.92
Ag_2BiI_5:Na	25.06	12.59	61.24	1.11	2.95
Ag_2BiI_5:K	25.29	12.72	61.86	1.13	2.97
Ag_2BiI_5:Rb	25.55	12.86	60.45	1.14	2.97
Ag_2BiI_5:Cs	25.70	13.07	60.05	1.18	3.04

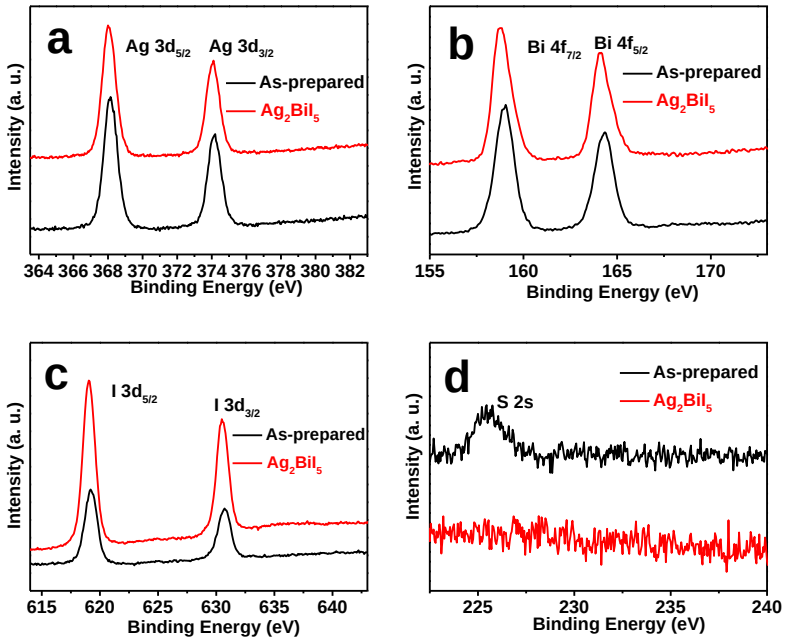

Fig. S4. XPS spectra (a) Ag 3d, (b) Bi 4f, (c) I 3d, (d) S 2s of Ag_2BiI_5 and as-prepared Ag-Bi-S-I thin films.

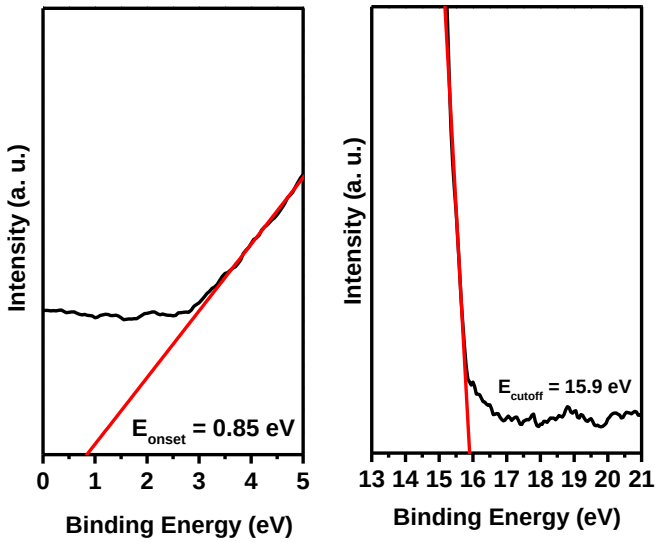

Fig. S5. UPS spectra of Ag_2BiI_5 thin film.

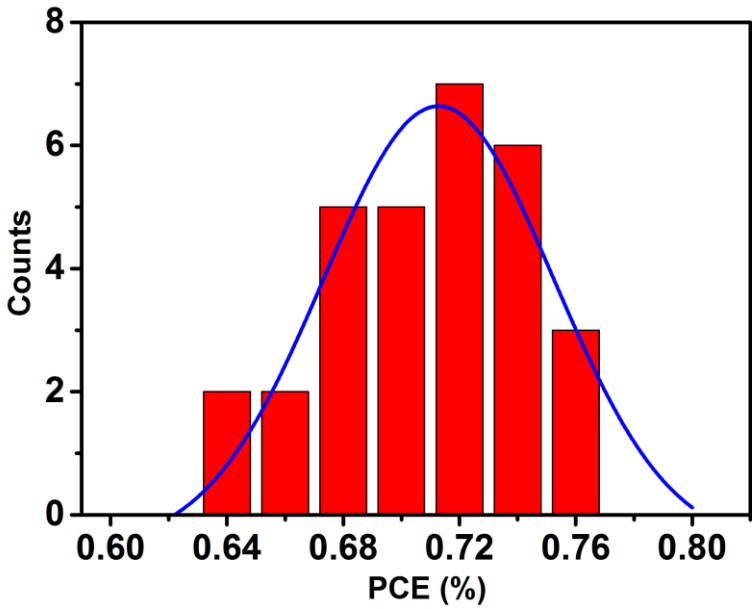

Fig. S6. Statistical efficiency distribution of 30 devices with the K^+-doped Ag_2BiI_5 absorber layers.

Table S2. PV parameters of the Ag_2BiI_5 solar cells with and without alkali doping (PTAA for HTL).

Sample	J_{SC} (mA/cm^2)	V_{OC} (V)	*FF* (%)	PCE (%)
w/o	1.21	0.68	45.97	0.38
Li^+	1.31	0.70	53.61	0.49
Na^+	1.55	0.69	54.89	0.59
K^+	1.95	0.68	56.20	0.75
Rb^+	1.64	0.69	54.43	0.62
Cs^+	1.42	0.42	43.17	0.26

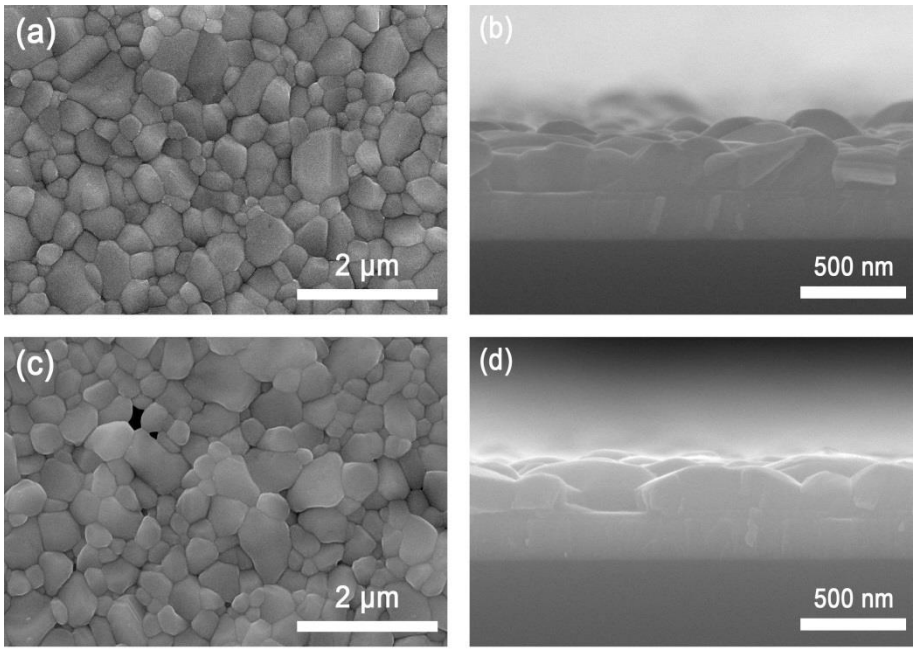

Fig. S7. Top-view and cross-sectional SEM images of 1% (a and b) and 2% (c and d) Cs^{+}-doped Ag_2BiI_5 thin films.

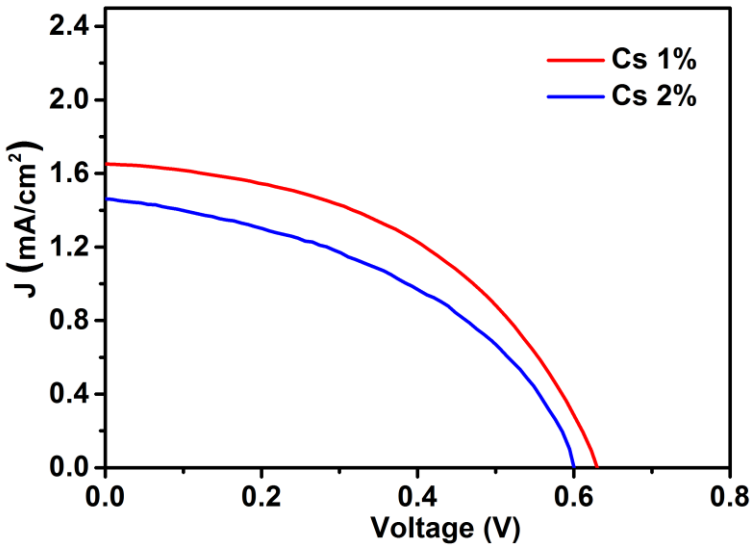

Fig. S8. *J-V* curves of 1% and 2% Cs^{+}-doped Ag_2BiI_5 solar cells.

Table S3. PV parameters of the 1% and 2% Cs^+-doped Ag_2BiI_5 solar cells (PTAA for HTL).

Sample	J_{SC} (mA/cm^2)	V_{OC} (V)	*FF* (%)	PCE (%)
1%	1.65	0.63	46.96	0.49
2%	1.46	0.60	44.03	0.39