

Table S1 Summary on representative progress of state-of-the-art perovskite solar cells by two-step fabrication under n-i-p configuration since 2019.

Years	V_{oc} (V)	J_{sc} (mA cm ⁻²)	FF (%)	PCE (%)	Type of cations	References
2019	1.16	24.9	81.4	23.56	Mixed-cations (FAMA)	Nature Photonics, 2019, 13(7): 460- 466.
2020	1.16	24.8	81.3	23.5	Mixed-cations (FAMAGA)	Advanced Materials. 2020, 32, 11.
2021	1.18	24.95	81.58	24.01	Mixed-cations (FAMA)	Energy Environ. Sci., 2021,14, 5074- 5083
2021	1.17	25.34	81.36	24.1	Single -cations (FA)	Science,2021, 371, 1359
2021	1.16	25.01	83.44	24.27	Mixed-cations (FAMACs)	Science, 2021, 373(6554): 561-567
2022	1.18	25.0	82.7	24.4	Mixed-cations (FAMA)	Advanced Materials, 2022, 34(8): 2106118.
2022	1.17	25.30	84.2	24.95	Mixed-cations (FAMA)	Joule, 2022, 6(12): 2869-2884.
2022	1.18	26.3	82.7	25.6	Single -cations (FA)	Science,2022,377, 531–534
2023	1.171	25.28	84.57	25.03	Mixed-cations (FAMA)	Advanced Materials, 2023: 2210186.
2023	1.18	25.77	83.50	25.39	Single-cations (FA)	Nature Communications, 2023, 14(1): 6125.
2023	1.17	25.72	83.67	25.17	Mixed-cations (FAMA)	Nature Photonics, 2023: 1-9
2023	1.19	26.39	82.94	26.07	Single-cations (FA)	Nature, (2023) 1476-4687 (online)
2023	1.16	25.76	84.35	25.23	Mixed-cations (FAMA)	This work