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Supplementary Materials

Progress in Perovskite Solar Cells towards Commercialization—A Review

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Table S1. Reports on perovskite solar modules (PSMs) from 2014 to July 2021.

Pub. Date	Module structure	Methods	GFF (%)	Active/Aperture area (cm[2])	Active/Aperture PCE (%)	Flexible (Yes / No)	Ref.
2014.12.05	FTO/TiO_2/$MAPbCl_3$/CuPc/Au	Spin-coating	*	*/8	*/2.66	No	[1]
2014.12.24	FTO/TiO_2/$MAPbI_3$/Spiro-OMeTAD/Au	Blade-coating	73	10.1/13.83	10.4/7.59	No	[2]
2015.07.24	FTO/NR-TiO_2/$MAPbCl_3$/Spiro-OMeTAD/Au	Screen printing	*	10.8/*	10.5/*	No	[3]
2016.01.05	ITO/TiO_2/$MAPbI_xCl_{3-x}$/Spiro-OMeTAD/Au	Spin-coating	91	3.64/4	14.9/13.6	No	[4]
2016.07.08	FTO/TiO_2/$MAPbI_3$/Spiro-OMeTAD/Au	Chemical vapor deposition (CVD)	*	8.8/~18.5	9.5/~4.5	No	[5]
2016.07.10	ITO/NiO/$MAPbI_3$/PCBM/ZnO/TCA/AgNWs	Blade-coating	91	*/3.3	*/9.75	Yes	[6]
2016.07.30	ITO/PEDOT:PSS/$MAPbI_xCl_yBr_{3-x-y}$/PCBM/Al	Spin-coatign	*	25.2/*	14.3/*	No	[7]
206.09.20	FTO/TiO_2/$MAPbI_xCl_{3-x}$/PTAA/Au	Spray-coating	40	40/100	15.5/6.2	xx	[8]
2016.10.20	FTO/NiO/$MAPbI_3$/PCBM/Ag	Spin-coating	60	15/25	12/7.2	No	[9]
2016.10.27	FTO/TiO_2-Graphee/GO-Li/$MAPbI_3$/Spiro-OMeTAD/Au	Spin-coating	73	50.56/69.52	12.6/9.20	No	[10]
2016.11.09	FTO/TiO_2/ZrO_2/$MAPbI_3$/Carbon	Screen printing	70	70/100	10.74/7.52	No	[11]
2017.01.31	FTO/TiO_2/ZrO_2/$MAPbI_3$/Carbon	Screen printing	96	49/51	10.4/9.98	No	[12]
2017.02.17	ITO/PEDOT:PSS/$MAPbI_3$/PCBM/Al	Spin-coating	*	11.25/*	15.4/*	No	[13]
2017.05.20	FTO/TiO_2/$MAPbI_xCl_{3-x}$/Spiro-OMeTAD/Au	Blade-coating	88	11.09/12.6	14.06/12.37	No	[14]
2017.06.24	ITO/NiO/$MAPbI_3$/PCBM-BCP/Ag	Spin-coating	54	13.5/25	11.8/6.37	No	[15]
2017.07.18	FTO/TiO_2/$MAPbI_3$/Spiro-OMeTAD/Au	Spin-coating	57	14.3/25	14.28/8.17	No	[16]
2017.02.17	FTO/TiO_2/$MAPbI_3$/Spiro-OMeTAD/Au	Pressure-assisted processing	*	*/36	*/12.1	No	[17]
2017.09.07	FTO/TiO_2/$MAPbI_3$/Spiro-OMeTAD/Au	Spin-coating	95	14.5/15.28	9.3/8.37	No	[18]
2017.10.05	FTO/TiO_2-SnO_2/$MAFAPbI_xBr_{3-x}$/Spiro-OMeTAD/Au	Spin-coating	*	10/*	14.39/*	No	[19]
2017.11.16	ITO/TiO_2/$MAPbI_xCl_{3-x}$/Spiro-OMeTAD/Au	Slot die coating	95	142/149.5	11.8/11.2	No	[20]
2017.11.22	ITO/TiO_2/$CsFAPbI_3$/Spiro-OMeTAD/Au	CVD	*	12/*	14.6/*	No	[21]
2017.11.28	FTO/TiO_2/$MAPbI_3$/Spiro-OMeTAD/Au	Spin-coating	*	10.1/*	13/*	No	[22]
2018.01.02	FTO/TiO_2/$MAFAPbI_3$/Spiro-OMeTAD/Au	Blade-coating	87	9.01/10.36	17.9/15.6	No	[23]

2018.01.11	ITO/C_{60}/$MAPbI_3$/ Spiro-OMeTAD/MoO_3-Au	Spin-coating	*	16/*	12.7/*	Yes	[24]
2018.03.14	FTO/TiO_2-SnO_2/$MAFAPbI_3$/Spiro-OMeTAD/Au	Chemical deposition	*	10.56/*	16.31/*	No	[25]
2018.04.10	FTO/SnO_2/$KCsFAMAPbI_xBr_{3-x}$/Spiro-OMeTAD/Au	Spin-coating		*/10	*/12.4	Yes	[26]
2018.04.30	FTO/SAH-TiO_2/$MAPbI_3$/Spiro-OMeTAD/Au	Soft-Cover-Assisted deposition	*	*/16	*/14.01	No	[27]
2018.05.12	FTO/TiO_2-SnO_2/$MAPbI_3$/Spiro-OMeTAD/Au	Spin-coating	*	12/*	8.8/*	Yes	[28]
2018.05.14	ITO/PTAA/$MAPbI_3$/C_{60}/BCP/Cu	Blade-coating	93	*/33 */57.2	*/15.3 */14.6	No	[29]
2018.08.13	FTO/TiO_2/ZrO_2/$MAPbI_3$/Carbon	Screen printing	46	198/435.6	6.6/3.03	No	[30]
2018.09.01	FTO/SnO_2/$MAPbI_3$/Spiro-OMeTAD/Au	Spin-coating	64	16/25	11.5/7.36	No	[31]
2018.10.15	PDMS/PEDT:PSS/$FAMAPbI_xBr_{3-x}$/PCBM/PEI-PEDOT:PSS/PDMS	Spin-coating	*	*/56.02	*/7.91	Yes	[32]
2018.11.02	ITO/SnO_2/$CsFAMAPbI_3Br_{3-x}$/Spiro-OMeTAD/Au	Slot-die printing	*	*/16.07	*/15.22	Yes	[33]
2018.11.02	FTO/SnO_2/2D-3D perovskite/Spiro-OMeTAD/Au	Printing method	*	57/*	11.59/*	No	[34]
2019.02.14	FTO/SnO_2/$FAPbI_xBr_{3-x}$/Spiro-OMeTAD/Au	CVD	*	12/*	14.7/*	No	[35]
2019.02.18	FTO/SnO_2/C_{60}/$CsFAPbI_xBr_{3-x}$/Spiro-OMeTAD/Au	CVD	90	82.6/91.8	10.37/9.34	No	[36]
2019.02.27	FTO/TiO_2/ZrO_2/$MAPbI_3$/Cu:NiO_x/Carbon	Screen printing	70	70/100	12.1/8.47	No	[37]
2019.03.15	FTO/SnO_2/$FAMAPbI_xBr_{3-x}$/Spiro-OMeTAD/Au	Spin-coating	*	*/53.64	*/13.85	No	[38]
2019.03.27	FTO/TiO_2/$FAMAPbI_xBr_{3-x}$/WBH/P3HT/Au	Bar-coating	*	*/24.97	*/17.1	No	[39]
2019.04.15	FTO/TiO_2-SnO_2/$FAMAPbI_xBr_{3-x}$/Spiro-OMeTAD/Au	Spin-coating	*	*/15	*/16.73	No	[40]
2019.04.29	FTO/TiO_2/$MAPbI_3$/Spiro-OMeTAD/Au	Blade-coating	81	22/27.25	14.2/11.5	No	[41]
2019.05.16	ITO/CuO/$MAPbI_xBr_{3-x}$/PCBM/BCP/Ag	Spin-coating	93	25/26.88	15/14	No	[42]
2019.06.25	FTO/TiO_2/$MAPbI_3$/Spiro-OMeTAD/Au	Blade-coating	91 87	14.2/15.91 47.68/55	12.85/11.7 14.7/12.7	No	[43]
2019.07.03	PET/PEDOT:PSS/$FAMAPbI_xBr_{3-x}$/PCBM/Ag	Slot-die printing	*	*/25	*/10.9	Yes	[44]
2019.07.04	FTO/SnO_2/$FAMAPbI_xBr_{3-x}$/Spiro-OMeTAD/Au	Spin-coating	93	*/53.64	*/17.4	No	[45]
2019.09.16	FTO/TiO_2/$MAPbI_3$/Carbon	Printing method	*	52/*	10.2/*	No	[46]
2019.11.21	ITO/PTAA/$MAPbI_3$/C_{60}/BCP/Cu	Blade-coating	*	*/42.9	*/15.86	Yes	[47]
2019.12.13	FTO/SnO_2/$MAPbI_3$/Spiro-OMeTAD/Au	Sputtered	91	20.75/22.8	13.22/12.03	No	[48]

2019.12.16	FTO/TiO_2/$MAPbI_xCl_{3-x}$/Spiro-OMeTAD/Au	Spin-coating	96	39.17/40.8	9.41/9.04	No	[49]
2020.01,03	FTO/TiO_2/$CsFAMAPbI_xBr_{3-x}$/Spiro-OMeTAD/Au	Blade-coating	*	50/* 17/*	11.6/* 12.7*	No	[50]
2020.01.15	FTO/NiO_x/$CsPbI_xBr_{3-x}$/ZnO-C_{60}/Ag	Quasi-curved heating method	*	10.92/*	12/*	No	[51]
2020.01.15	ITO/PEDOT:EVA/$FAMAPbI_xBr_{3-x}$/PCBM/Ag	Scribing method	87	31.2/35.86	17.55/15.21	Yes	[52]
2020.01.17	FTO/SnO_2/$CsFAMAPbI_xBr_{3-x}$/Spiro-OMeTAD/Au	spin-coating	91	*/25.49	*/18.73	No	[53]
2020.01.29	FTO/SnO_2/$MAPbI_3$/Spiro-OMeTAD/Au	Spray-coating	87	15/17.24	9.37/8.15	No	[54]
2020.02.14	FTO/TiO_2/ZrO_2/$MAPbI_3$/Carbon-Cu	Screen printing	*	11.7/*	11/*	No	[55]
2020.03.11	FTO/ZnO-ZnS/TiO_2/$MAPbI_3$/Spiro-OMeTAD/Au	Dip-coating	*	*/12	*/16	No	[56]
2020.04.01	FTO/TiO_2/ZrO_2/$MAPbI_3$/Carbon	Scribing method	*	*	10.37/*	No	[57]
2020.04.02	FTO/SnO_2/PCBM/$MAPbI_3$/Spiro-OMeTAD/Au	Co-evaporated	72	21/29.16	18.13/13.05	No	[58]
2020.04.07	FTO/SnO_2/$FAMAPbI_xBr_{3-x}$/Spiro-OMeTAD/Au	Blade-coating		*/10 */53.6	*/16.54 */13.32	No	[59]
2020.04.16	FTO/SnO_2/$CsFAMAPbI_xBr_{3-x}$/Spiro-OMeTAD/Au	D-bar coating	75	18.66/25	*/17.01	No	[60]
2020.04.24	FTO/ZnO-ZnS/TiO_2/$CsPbI_3$/Spiro-OMeTAD/Au	Blade-coating	*	*/16	*/11.8	No	[61]
2020.04.28	FTO/TiO_2/ZrO_2/$MAPbI_3$/Carbon	Slot-die coating	75	60.08/80.55	12.87/9.65	No	[62]
2020.05.07	FTO/ PEDOT:PSS/$MAPbI_3$/C_{60}/BCP/Ag	Blade-coating	*	10.56/*	13.03/*	No	[63]
2020.05.11	FTO/SnO_2/$FAMAPbI_3Br_{3-x}$/Spiro-OMeTAD/Au	Spin-coating	98	24.5/25	16.27/16	No	[64]
2020,06.25	FTO/SnO_2/$FAMAPbI_3$/Spiro-OMeTAD/Au	Spin-coating		*/25.9	*/17.33	No	[65]
2020.08.29	ITO/PEDOT:PSS/2T-NATA/$MAPbI_3$/C_{60}/BCP/ Ag	Evaporated	*	16/*	15.06/* 13.15/*	Yes	[66]
2020.10.19	FTO/SnO_2/$FACsPbI_3$/Spiro-OMeTAD/Au	Chemical vapor deposition	90	*/22.4	*/12.3%	No	[67]
2020.10.20	FTO/TiO_2/$FAMAPbI_xCl_{3-x}$/$[M_4N]BF_4$/Spiro-OMeTAD/Au	Slot-die coating	86	10.2/11.86 7.92/9.2	18.6/15.9 19.6/16.77	No	[68]
2020.10.22	FTO/Zn_2SnO_4/SnO_2/$FACsPbI_3$/Spiro-OMeTAD/Au	Blade-coating	90	*/100 */225 */400	*/15.5 */12.9 */11.8	Yes	[69]
2020.12.09	FTO/TiO_2/Perovskite/PTAA/Au	Spin-coating	86	42.8/50	17.05/14.66	No	[70]
2020.12.16	ITO/NiO/$CsFAPbI_3$/C_{60}/BCP/Ag	Spray-coating	90	5.9/6.55	15.2/13.68	No	[71]
2020.12.17	FTO/TiO_2/$CsFAPbI_3$/Spiro-OMeTAD/Au	Spin-coating	*	7.2/*	16.3/*	No	[72]

2020.12.18	FTO/SnO_2/FAMAPbI_xBr_{3-x}/Spiro-OMeTAD/Au	D-bar coating		19.69/*	17.46/*	No	[73]
2020.12.21	FTO/ZnO-ZnS/$FACsPbI_3$/Spiro-OMeTAD/Au	Spin-coating	*	49/*	13.84/*	No	[74]
2020.12.21	FTO/TiO_2/SnO_2/FACsPbI_xCl_{3-x}/Spiro-OMeTAD /Au	Slot-die coating	*	*/35.8	*/15.3	No	[75]
2021.01.24	PEN/PEDOT:PSS/Perovskite/PCBM/Ag	Meniscus-coating	*	15/*	16.15/*	Yes	[76]
2021.01.25	FTO/SnO_2/FAMAPbI_xCl_{3-x}/Spiro-OMeTAD/Au	Spin-coating	84	77.47/91.8	12.14/10.25	No	[77]
2021.03.02	FTO/TiO_2/GO-K/FACsPbI_xBr_{3-x}/Spiro-OMeTAD /Au	Spin-coating	88	16/18.18	16.1/14.17	No	[78]
2021.03.05	PET/SnO_2/FAMACsPbI_xBr_{3-x}/Spiro-OMeTAD/Au	Spin-coating	87	21.8/25.05	11.7/10.18	No	[79]
2021.03.15	ITO/SAM/ FAMACsPbI_xBr_{3-x}/LiF/C_{60}/SnO_2/Cu	Spin-coating	*	19.4/*	2.2/*	No	[80]
2021.03.21	ITO/PEDOT:PSS/$MAPbI_3$/PCBM/BCP/Ag	Spin-coating	70	10/14.28	8.8	No	[81]
2021.03.29	ITO/PTAA/MAPbI_xCl_{3-x}/C_{60}/BCP/Cu	Blade-coating	*	*/60.8	*/16.3	No	[82]
2021.04.30	ITO/NiMgLiO/FACsPbI_xBr_{3-x}/LiF/C_{60}/BCP/Bi/ Ag	Slot-die coating	93	19.29/20.77	/15.42	No	[83]
2021.05.03	ITO/PTAA/$MAFAPbI_3$/C_{60}/BCP/Cu	Blade-coating	94	*/18.2	*/35.8	No	[84]
2021.05.07	ITO/SnO_2/FAPb$I_{3-x}Br_x$/Spiro-OMeTAD/Au	Spin-coating	89	19.93/22.4	16.01/14.22	No	[85]
2021.06.09	ITO/SnO_2/$MAPbI_3$/P3HT/Ta-WO_x/Carbon	Blade-coating	*	*/*	15.3	No	[86]
2021.06.16	PET/PTAA/ FACsPbI_xBr_{3-x}/C_{60}/BCP/Ag	Blade-coating		15.7/*	10.51/*	Yes	[87]
2021.07.08	FTO/PTAA/$FACsPbI_3$/Spiro-OMeTAD/Au	Spin-coating	*	18/*	18.1/*	No	[88]
2021.07.09	FTO/TiO_2/ $FAPbI_3$/Spiro-OMeTAD /Au	Spin-coating	90	23.27/25.74	20.75/19.76	No	[89]
2021.07.10	FTO/SnO_2/FAMACsPb$I_{3-x}Br_x$/Spiro-OMeTAD/Au	Spin-coating	91 86	22.4/24.75 91.8/106.74	17.26/15.62 13.72/11.79	No	[90]
2021.07.20	ITO/SnO_2/EDTAK/FAMACsPb$I_{3-x}Br_x$/Spiro-OMeTAD/Au	Spin-coating	*	*/22.4	*/16.6	No	[91]
2021.07.21	FTO/NiO_x/PTAA/Al_2O_3/Perovskite/PCBM/BCP/SnO_2/Ag	Spin-coating	*	11.2/*	16.9/*	No	[92]

Note: In this table, related parameters of PSMs reported from 2014 to 2021 are presented, reflecting the power conversion efficiency (PCE) and module area development of PSMs.

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