Electronic Supplementary Material (ESI) for Nanoscale.

Supplementary Materials

Highly Flexible Organo-Metal Halide Perovskite Solar Cells Based on Silver Nanowire–Polymer Hybrid Electrodes

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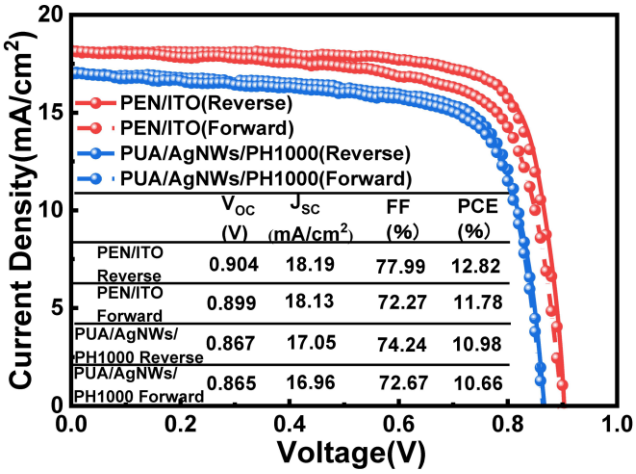

Figure S1. Current density-voltage (J-V) characteristics of perovskite solar cells based on PEN/ITO and PUA/AgNWs/PH1000 by reverse and forward scan. The solid and dashed lines represent the reverse and forward scans, respectively.

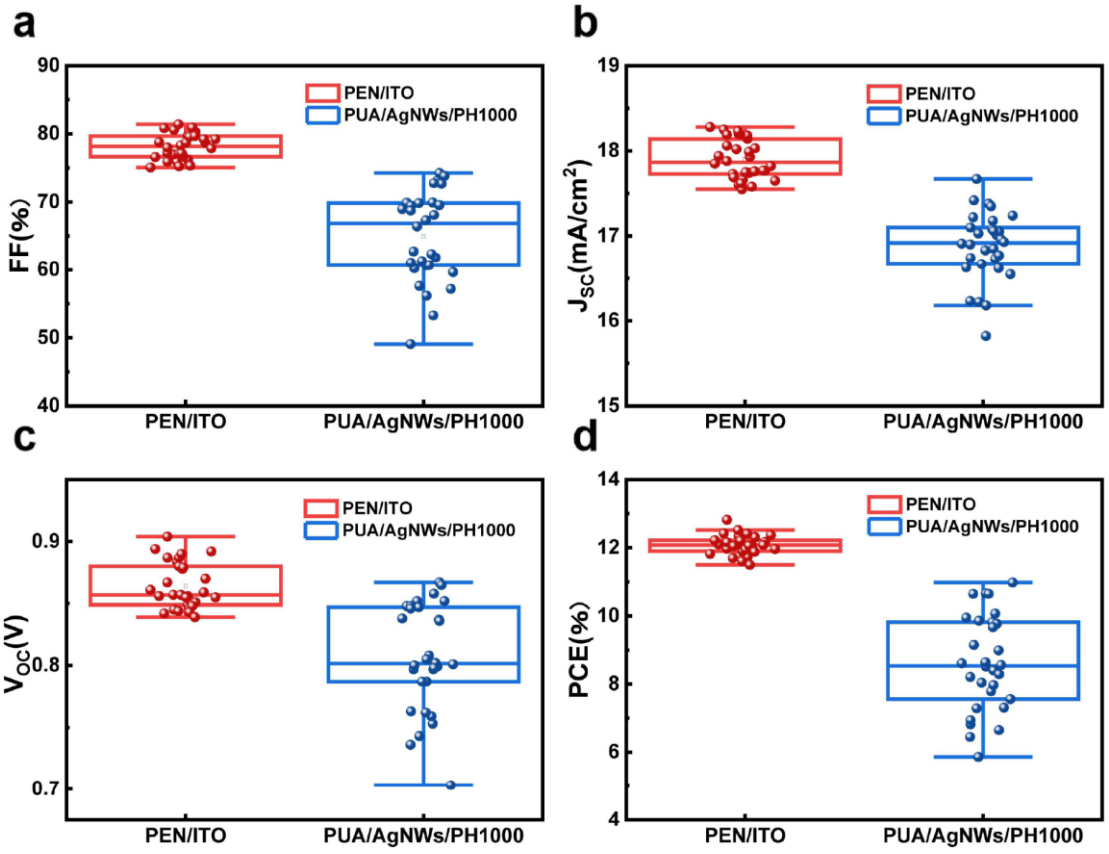

Figure S2. The statistics of a) FF, b) J_{SC}, c) V_{OC} and d) PCE distribution of the flexible perovskite solar cells (FPSCs) based on PEN/ITO and PUA/AgNWs/PH1000. The data of each histogram are extracted from 30 individual FPSCs.

Table S1: Figure of Merit (FoM) of various conductive films.

FoM	**1 time-PUA/AgNWs**	**2 times-PUA/AgNWs**	**3 times-PUA/AgNWs**
	184.79	246.32	226.47
FoM	**1 time-PUA/AgNWs /PH1000**	**2 times-PUA/AgNWs /PH1000**	**3 times-PUA/AgNWs /PH1000**
	103.84	133.22	121.50
FoM	**PEN/ITO**		
	92.37		

Table S2: Photovoltaic performance of champion PEN/ITO-FPSCs and PUA/AgNWs/PH1000-FPSCs.

Champion Cell	**V_{OC} (V)**	**J_{SC} (mA/cm²)**	**FF (%)**	**PCE (%)**
PEN/ITO	0.904	18.19	77.99	12.82
PUA/AgNWs/PH1000	0.867	17.05	74.24	10.98

Table S3: Photovoltaic performance of PEN/ITO-FPSCs and PUA/AgNWs/PH1000-FPSCs scanned from forward and reverse directions.

	Scan direction	**V_{OC} (V)**	**J_{SC} (mA/cm²)**	**FF (%)**	**PCE (%)**	**Average PCE (%)**	**$H_{hysteresis}$†**
PEN/ITO	Reverse	0.904	18.19	77.99	12.82	12.30	8.11
	Forward	0.899	18.13	72.27	11.78		
PUA/AgNWs /PH1000	Reverse	0.867	17.05	74.24	10.98	10.82	2.91
	Forward	0.865	16.96	72.67	10.66		

†The hysteresis index can be calculated by the following equation[1]:

$$H_{hysteresis} = \frac{PCE_{reverse} - PCE_{forward}}{PCE_{reverse}}$$

Table S4: Comparison of PCE and mechanical stability of FPSCs based on different flexible transparent electrodes.

Electrodes	Optimal PCE [%]	Bending Radius [mm]	Bending Cycle [times]	Retained PCE [%]
AgNWs/PH1000[2]	11.44	5	1,500	86
AgNWs/PH1000[3]	15.06	5	1,000	80
graphene-AgNWs[4]	9.73	7	1,000	~70
AgNWs[5]	17.11	6	2,000	77
a-AZO/AgNW/AZO[6]	11.23	12.5	400	94
Ag grids[7]	18.49	6	1,000	60
Ag grid/PH1000[8]	14	5	5,000	95.4
Ag grid/PH1000[9]	14.52	15	5,000	86
Ag grid/ITO[10]	18.1	4	5,000	55.63
Cu grids/PH1000[11]	13.58	5	1,000	90
Ni grids[12]	17.3	4	2,000	76
Au[13]	9.05	3.5	2,000	74
IZO[14]	11.68	4	1,000	70
Graphene[15]	13.94	4	1,000	~92
Graphene[16]	11.9	4	2,000	86
AgNWs/PH1000 (this work)	10.98	5	5,000	97.9
AgNWs/PH1000 (this work)	10.98	5	10,000	77.4

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