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RESEARCH HIGHLIGHTS

Using fluorinated and crosslinkable fullerene derivatives to improve the stability of perovskite solar cells

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SUPPORTING INFORMATION

Table 1. The fluorinated and crosslinkable fullerene derivatives, their application in PSCs, and device performance details.

Fullerene derivative	Active layer	Role	J_{sc} (mA/cm^2)	V_{oc} (V)	FF (%)	PCE (%)	Stability	Ref.
DF-C_{60}	$CH_3NH_3PbI_3$	Additive	21.08	1.09	78.7	18.11	83% retaining in ambient (60±5% RH) after 1 month	[11]
DF-C_{60}	$CH_3NH_3Pb_{0.5}Sn_{0.5}I_3$	Additive	26.1	0.87	69	15.61	50% retaining in ambient (60±5% RH) after 15 days	[12]
IS-1	$CH_3NH_3PbI_3$	Additive	16.7	1.03	69	11.8	–	[13]
IS-2	$CH_3NH_3PbI_3$	Additive	16.1	1.06	73.8	12.7	Nearly 80% retaining under AM1.5 simulated sunlight for 240 h	[13]
PI-1	$CH_3NH_3PbI_3$	Additive	–	–	–	–	–	[13]
PI-2	$CH_3NH_3PbI_3$	Additive	16.1	1.02	69.4	11.7	–	[13]
3F-$PC_{61}BM$	$CH_3NH_3PbI_3$	Additive	21.78	1.00	73.34	16.17	80% retaining after 550 h in N_2 glove box	[14]
5F-$PC_{61}BM$	$CH_3NH_3PbI_3$	Additive	14.99	0.87	65.71	8.65	–	[14]
C_{60}-PyF15	$CH_3NH_3PbI_3$	Additive	23.14	1.073	80.96	20.10	85% retaining in ambient (~35% RH) after 1440 h 81% retaining under N_2 at 85 °C after 660 h	[15]
F-C_{60}	$CH_3NH_3PbI_{3-x}Cl_x$	CBL[a]	21.2	0.97	75.4	15.5	80% retaining in ambient (20% RH) after 14 days	[16]
CF_3-$PC_{61}BM$	$CH_3NH_3PbI_3$	ETL[b]	22.19	1.04	79.61	18.37	80% retaining at a room temperature after 25 days (40%–60% RH)	[17]
C_6F_{13}-$PC_{61}BM$	$CH_3NH_3PbI_3$	ETL	21.90	1.05	77.02	17.71	80% retaining at a room temperature after 33 days (40%–60% RH)	[17]
CF_3-$PC_{61}BM$	CsFAMAPbIBr	ETL	23.47	1.04	77.49	19.00	–	[17]
C_6F_{13}-$PC_{61}BM$	CsFAMAPbIBr	ETL	23.45	1.04	76.33	18.65	–	[17]
FP-i	$CH_3NH_3PbI_{3-x}Cl_x$	ETL	20.85	0.93	69.76	13.60	70%–85% retaining in air (40%–50% RH) after 70 h	[18]
FP-ii	$CH_3NH_3PbI_{3-x}Cl_x$	ETL	21.40	0.93	71.55	14.23	70%–85% retaining in air (40%–50% RH) after 70 h	[18]
Sol-gel C_{60}	$CH_3NH_3PbI_{3-x}Cl_x$	ETL	23.0	1.07	73	17.9	–	[20]
PCBCB	$CH_3NH_3PbI_{3-x}Cl_x$	ETL	22.4	1.11	73	17.9	–	[20]
$MPMIC_{60}$	$CH_3NH_3PbI_3$	ETL	20.2	1.08	64	13.8	10-fold and 14-fold enhancement in fracture resistance over $PC_{61}BM$ and C_{60}	[19]
C-PCBSD	$CH_3NH_3PbI_{3-x}Cl_x$	Additive	22.81	0.98	77	17.21	84.6% retaining in ambient (40±5% RH) after 180 h	[21]
C-PCBSD	$CH_3NH_3PbI_3$	Modify TiO_2	21.1	1.12	79.0	18.7	–	[22]
C-PCBSD: GD	$CH_3NH_3PbI_3$	Modify TiO_2	23.30	1.11	78	20.19	80% retaining in ambient (25%–30% RH) after 500 h	[23]
PCBCB: CL	$Cs_{0.05}(FA_{0.85}MA_{0.15})_{0.95}$-$Pb(I_{0.9}Br_{0.1})_3$	ETL	22.9	1.08	78	18.5	92% retaining of their stabilized power output after aging for 3000 h at 85 °C in N_2	[24]
C-PCBOD	$CH_3NH_3PbI_3$	Modify TiO_2	23.99	1.041	73.25	18.29	–	[25]
C-PCBOD	$CH_3NH_3PbI_3$	Additive	22.60	1.14	79	20.4	72% retaining in ambient (20±5% RH) after 960 h	[26]
PCBM with DAZH	$FA_{0.66}MA_{0.34}PbI_{2.85}Br_{0.15}$	Modify TiO_2	21.9	1.05	79.1	18.4	–	[27]

[a] Cathode buffer layer; [b] Electron-transport layer.

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