Electronic Supplementary Material (ESI) for Energy & Environmental Science.

Supporting Information

for

Environmental Analysis of Perovskites and Other Relevant Solar Cell Technologies in a Tandem Configuration

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Table S. 1 The material inventories for Si-PK preparation

Layers	Thicknesses (m)	Mass (kg/m^2)	Reference
ITO	1.10E-07	7.90E-04	[1]
MoO_3	1.00E-08	4.69E-05	This study
Spiro-OMeTAD	1.50E-07	1.59E-04	[1]
Perovskite	3.50E-07	6.09E-04	[2]
PCBM	2.00E-08	3.00E-05	[3]
ZnO:In	3.00E-08	2.10E-04	[4]
p-aSi	1.00E-08	2.33E-05	[5]
i-aSi	5.00E-09	1.17E-05	[5]
n-type FZ Si wafer	3.00E-04	6.99E-01	[6]
i-aSi	5.00E-09	1.17E-05	[5]
n-aSi	1.00E-08	2.33E-05	[5]
ITO	8.00E-08	5.74E-04	[1]
Ag	1.00E-07	1.05E-03	[7]

Table S. 2 The material inventories for CIGS-PK preparation

Layers	Thicknesses (m)	Mass (kg/m^2)	Reference
FTO Coated Glass	1.00E-03	2.50E+00	[1]
mp-TiO_2	2.00E-07	8.46E-04	[1]
Perovskite	3.00E-07	6.09E-04	[2]
Spiro-OMeTAD	2.00E-07	2.12E-04	[1]
MoO_3	1.00E-08	4.69E-05	This study
ZnO/ZnO-Al	1.30E-07	2.81E-04	This study
CdS	5.00E-08	2.41E-04	[4]
CIGS	2.00E-06	1.14E-02	[6]
Mo	6.00E-07	6.17E-03	[4]
Glass	1.00E-03	2.50E+00	[2]

Table S. 3 The material inventories for CZTS-PK preparation

Layers	Thicknesses (m)	Mass (kg/m^2)	Reference
Glass	1.00E-03	2.50E+00	[2]
Mo	6.00E-07	6.17E-03	[4]
CZTS	2.00E-06	9.20E-03	[4]
CdS	3.00E-08	1.45E-04	[4]
ITO	5.00E-08	3.59E-04	[1]
PEDOT:PSS	5.00E-08	5.00E-05	[8]
Perovskite	3.00E-07	6.09E-04	[2]
PCBM	2.00E-08	3.00E-05	[3]
Al	1.00E-07	2.70E-04	[2]

Table S. 4 The material inventories for PK-PK preparation

Layer	Thickness (nm)	Mass (kg/m^2)	Reference

ITO	200	1.79 E-03	[3]
NiO	10	8.33 E-05	This study
$CH3NH3PbI_3$	350	6.09 E-04	[2]
PCBM	10	1.25 E-05	[3]
ITO	100	8.95 E-04	[3]
PEDOT:PSS	30	3.75 E-05	[8]
$CH3NH3SnI_3$	350	4.37 E-04	[9]
PCBM	10	1.25 E-05	[3]
Ag	80	1.05 E-03	[3]

Table S. 5 Material and energy inventory of manufacturing 1 m^2 of NiO layer (10 nm)

Layer		Unit	Amount
M	Nickel, at plant	kg	1.66 E-06
M	Oxygen, liquid, at plant	kg	4.58 E-08
E	Heat consumption	MJ	1.40 E+00
E	UCTE Electricity, production mix	MJ	9.98 E-01
W	Deposition waste	kg	1.50 E-05
W	Waste Heat	kg	1.40 E+00

Table S. 6 Material and energy inventory of manufacturing 1 m^2 of MoO_3 layer (10 nm)

Layer		Unit	Amount
M	Molybdenum disulfide, at plant	kg	6.80 E-03
M	Oxygen, at plant	kg	2.93 E-04
E	UCTE Electricity, production mix	MJ	5.96 E-01
W	Sulfur Oxides	kg	5.37 E-03
W	Deposition waste	kg	4.69 E-05

Table S. 7 Material and energy inventory of manufacturing 1 m^2 of ZnO/ZnO:Al layer (130 nm)

Layer		Unit	Amount
M	Aluminum, at plant	kg	2.70 E-04
M	Methanol, at plant	kg	3.48 E-04
M	Acetic acid, 98 % in H2O, at plant	kg	2.95 E-06

M	Hydrogen peroxide, 50 % in H_2O, at plant	kg	7.81 E-11
M	n-butanol, at plant	kg	2.32 E-04
M	Potassium hydroxide, at regional storage	kg	2.70 E-06
M	Zinc oxide, at plant	kg	3.74 E-04
E	UCTE Electricity, production mix	MJ	1.34 E+01
W	Deposition waste	kg	7.03 E-05

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