Supporting Information

Efficient and Stable Solid State Dye Sensitized Solar Cells by Combination of Phosphonium Organic Ionic Plastic Crystals with Silica

*Annkatrin Lennert[1,2], Klaudia Wagner[1,3], Ruhamah Yunis[4], Jennifer M. Pringle[4], Dirk M. Guldi[2] and David L. Officer[1,3]**

[1]ARC Centre of Excellence for Electromaterials Science, Innovation Campus, University of Wollongong, North Wollongong, NSW 2522, Australia

[2]Department of Chemistry and Pharmacy & Interdisciplinary Center for Molecular Materials (ICMM), Friedrich-Alexander-Universität Erlangen-Nürnberg, Egerlandstrasse 3, 91058 Erlangen, Germany

[3]Intelligent Polymer Research Institute, AIIM Faculty, Innovation Campus, University of Wollongong, North Wollongong, NSW 2522, Australia

[4]ARC Centre of Excellence for Electromaterials Science, Institute for Frontier Materials, Deakin University, Geelong, Australia

* Email: davido@uow.edu.au

Tables and Figures

Table S1. Figures of merit for devices with quasi-solid-state electrolytes based on plastic crystals [P_{1222}][FSA] (**B**) and [P_{1222}][TFSA] (**G**) on 2.5 μm TiO_2 layer thicknesses measured at RT. "Reference electrolyte" refers to the liquid electrolyte system. Measurements taken at RT.

Electrolyte	V_{OC} **[V]**	J_{SC} **[mA/cm^2]**	**FF**	**PCE [%]**
Reference				
1 sun	0.94	4.93	0.73	3.38
0.58 sun	0.92	2.78	0.74	3.24
0.38 sun	0.91	1.75	0.77	3.23
0.13 sun	0.87	0.57	0.77	2.94
Electrolyte **B**				
1 sun	0.68	4.40	0.64	1.91
0.58 sun	0.66	2.65	0.66	1.99
0.38 sun	0.65	1.77	0.68	2.06
0.13 sun	0.60	0.62	0.71	2.03
Electrolyte **G**				
1 sun	0.68	2.8	0.84	1.60
0.58 sun	0.67	2.11	0.81	1.97
0.38 sun	0.65	1.60	0.73	2.00
0.13 sun	0.61	0.61	0.73	2.09

Table S2. Figures of merit for devices with quasi-solid-state electrolytes based on plastic crystals [P_{1222}][FSA] (**B**) and [P_{1222}][TFSA] (**G**) on 2.5 µm, 12 µm, 18 µm and 24 µm TiO_2 thicknesses and for the Reference electrolyte on 18 µm TiO_2. "Reference electrolyte" refers to the liquid electrolyte system. Measurements taken at RT.

Electrolyte	Thickness [µm]	V_{OC} [V]	J_{SC} [mA/cm^2]	FF	PCE [%]
B	2.5	0.68	4.40	0.64	1.91
B	12	0.67	5.68	0.72	2.74
B	18	0.74	7.90	0.70	4.09
B	24	0.72	7.67	0.55	3.04
G	2.5	0.68	2.80	0.84	1.60
G	12	0.69	6.10	0.72	3.03
G	18	0.74	8.30	0.71	4.36
G	24	0.73	4.96	0.54	1.96
Reference	18	0.71	15.01	0.72	7.67

Table S3. Photovoltaic characteristics of DSSCs with electrolytes **B**, **C**, **D**, **E**, **G**, **H**, **J** and **K**, obtained immediately after fabrication (also reported in Tables 1 and 3, average of 8 devices) and the same devices retested after 5 months stored in the dark (average of 5 devices). The measurements were taken at RT.

	V_{OC} [V]	J_{SC} [mA/cm^2]	FF	PCE [%]
B [P_{1222}][FSA]	0.737 ± 0.01	7.9 ± 1.0	0.70 ± 0.02	4.09 ± 0.47
B after 5 months	0.661 ± 0.08	6.1 ± 1.0	0.71 ± 0.06	2.87 ± 0.60
C [P_{1222}][FSA] + 2% silica	0.727 ± 0.01	12.4 ± 0.6	0.65 ± 0.03	5.86 ± 0.45
C after 5 months	0.751 ± 0.01	10.3 ± 1.1	0.73 ± 0.04	5.68 ± 0.61
D [P_{1222}][FSA] + 5% silica	0.743 ± 0.01	12.0 ± 1.0	0.70 ± 0.02	6.24 ± 0.50
D after 5 months	0.716 ± 0.01	9.6 ± 2.5	0.74 ± 0.03	5.11 ± 1.51
E [P_{1222}][FSA] + 7% silica	0.775 ± 0.01	14.0 ± 1.0	0.68 ± 0.03	7.40 ± 0.44
E after 5 months	0.758 ± 0.02	8.6 ± 1.1	0.70 ± 0.02	4.54 ± 0.70
G [P_{1222}][TFSA]	0.741 ± 0.02	8.3 ± 1.1	0.71 ± 0.02	4.36 ± 0.55
G after 5 months	0.795 ± 0.01	5.6 ± 0.6	0.78 ± 0.05	3.46 ± 0.35
H [P_{1222}][TFSA] + 2% silica	0.742 ± 0.02	9.6 ± 1.7	0.63 ± 0.03	4.44 ± 0.65
H after 5 months	0.773± 0.01	8.5 ± 0.7	0.68 ± 0.03	4.51 ± 0.29
J [P_{1222}][TFSA] + 5% silica	0.746 ± 0.07	9.3 ± 1.6	0.63 ± 0.04	4.33 ± 0.63
J after 5 months	0.770 ± 0.02	7.5 ± 1.1	0.69 ± 0.05	3.97 ± 0.49
K [P_{1222}][TFSA] + 7% silica	0.747 ± 0.01	12.4 ± 1.0	0.63 ± 0.02	5.84 ± 0.52
K after 5 months	0.781 ± 0.01	8.34 ± 2.0	0.76 ± 0.04	4.86 ± 0.91

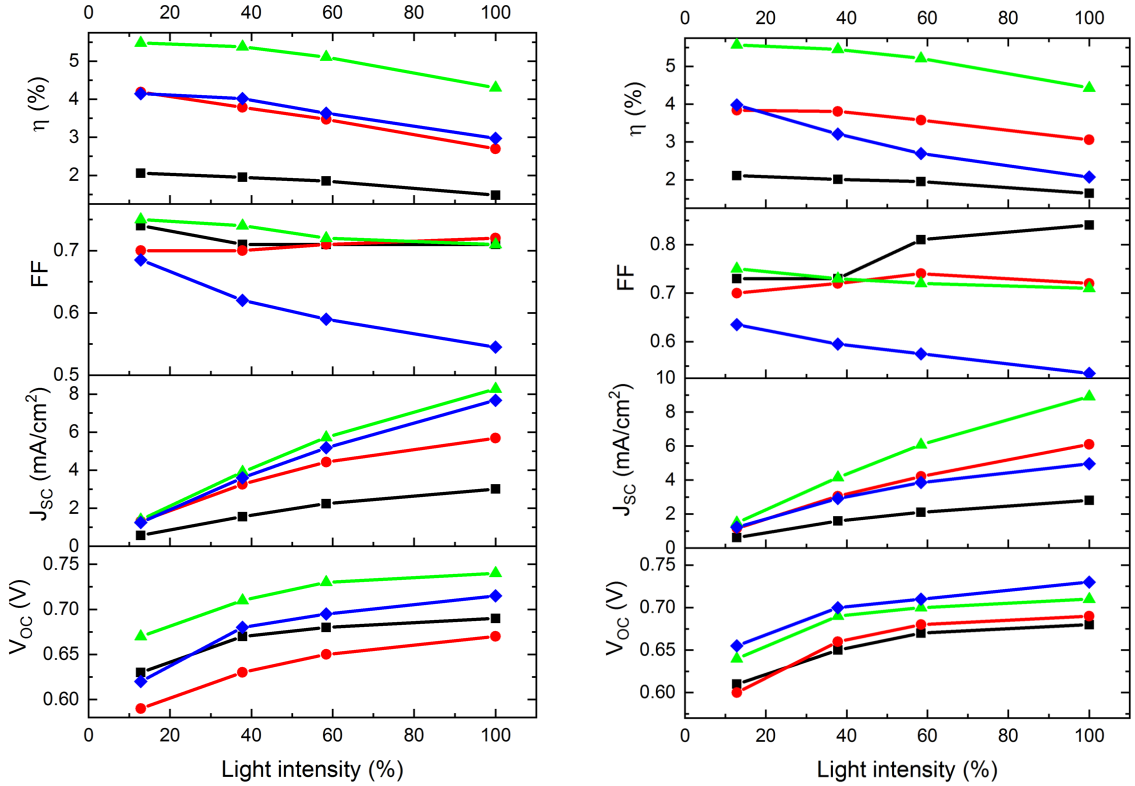

Figure S1. Plots of photovoltaic characteristics versus light intensity for quasi solid state DSSCs using electrolytes **B** (left side) and **G** (right side) with different TiO_2 layer thicknesses. Black line: 2.5 μm; red line: 12 μm; green line: 18 μm; blue line: 24 μm.

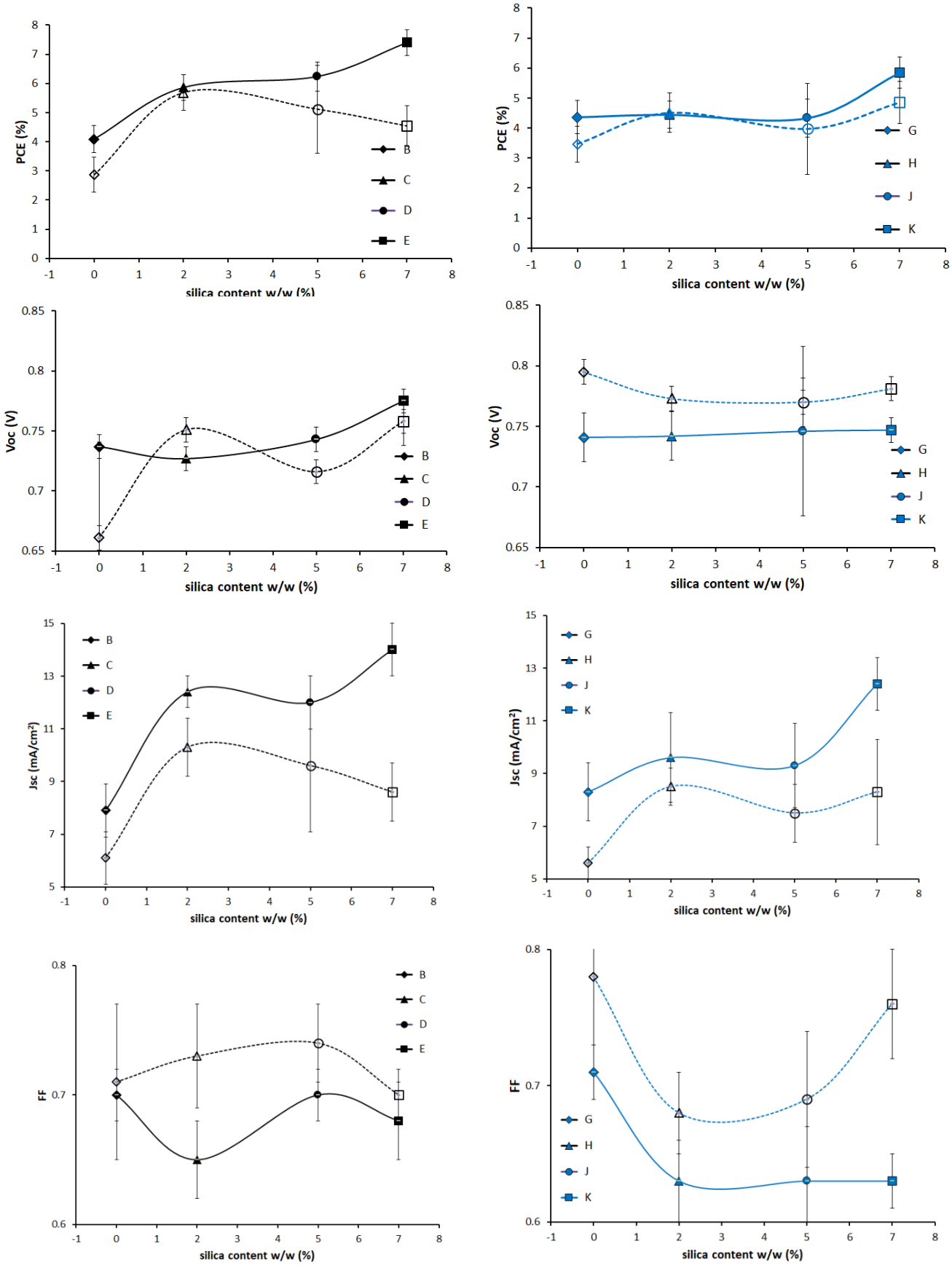

Figure S2. Photovoltaic efficiency (PCE), *J*sc, *V*oc and FF of quasi solid state DSSCs using electrolytes **B**, **C**, **D** and **E** (left side) and **G, H, J** and **K** (right side) immediately after fabrication (solid line) and after 5 months (dashed line).