

Energy harvester based on UV-polymerized short-alkyl-chain-modified [DBU][TFSI] ionic liquid electrets

Supplementary information

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Characterization results

1-ethyl-1, 8-diazobicyclo [5.4.0] undec-7-ene bis(trifluoromethane)sulfonamide [DBU-C2]TFSI

Transparent liquid; Yield 89.5 %; ¹H NMR (500 MHz, CDCl₃) δ = 3.63-3.61 (t, 2H), 3.55-3.52 (m, 4H), 3.50-3.48 (t, 2H), 2.82-2.80 (t, 2H), 2.14-2.09 (quint, 2H), 1.82-1.71 (m, 6H), 1.28-1.25 (t, 3H) ppm. ¹³C NMR (500 MHz, CDCl₃) δ = 166.29, 121.18, 55.19, 49.03, 48.96, 46.29, 28.49, 28.07, 25.91, 22.85, 19.89, 13.43 ppm. Water content: 348 ppm. Elemental analysis for C₁₃H₂₁F₆N₃O₄S₂ (M = 461.44 g mol⁻¹) calculated (%): C 33.84, H 4.59, N 9.11, S 13.90 and found (%): C 34.11, H 3.99, N 9.38, S 14.02.

1-butyl-1, 8-diazobicyclo [5.4.0] undec-7-ene bis(trifluoromethane)sulfonamide [DBU-C4]TFSI

Yellowish liquid; Yield 93.0 %; ¹H NMR (500 MHz, CDCl₃) δ = 3.64-3.62 (t, 2H), 3.56-3.53 (t, 2H), 3.52-3.49 (t, 2H), 3.47-3.44 (t, 2H), 2.82-2.80 (t, 2H), 2.14-2.09 (quint, 2H), 1.83-1.72 (m, 6H), 1.64-1.57 (m, 2H), 1.39-1.32 (dq, 2H), 0.97-0.94 (t, 3H) ppm; ¹³C NMR (500 MHz, CDCl₃) δ = 166.42, 121.18, 55.26, 53.98, 49.09, 47.07, 30.54, 28.48, 28.26, 25.90, 22.98, 19.90, 19.72, 13.55 ppm. Water content: 673 ppm. Elemental analysis for C₁₅H₂₅F₆N₃O₄S₂ (M = 489.50 g mol⁻¹) calculated (%): C 36.81, H 5.15, N 8.58, S 13.10 and found (%): C 36.45, H 4.78, N 9.08, S 13.08.

1-hexyl-1, 8-diazobicyclo [5.4.0] undec-7-ene bis (trifluoromethane) sulfonamide [DBU-C6]TFSI

Yellowish liquid; Yield 93.2 %; ¹H NMR (500 MHz, CDCl₃) δ = 3.65-3.63 (t, 2H), 3.58-3.53 (t, 2H), 3.53-3.48 (t, 2H), 3.48-3.42 (t, 2H), 2.14-2.10 (quint, 2H), 1.82-1.72 (m, 8H), 1.63-1.60 (t, 2H), 1.31 (s, 6H), 0.91-0.88 (t, 3H) ppm; ¹³C NMR (500 MHz, CDCl₃) δ = 166.47, 121.15, 55.28, 54.23, 49.07, 47.06, 38.51, 31.23, 28.55, 28.30, 26.13, 25.93, 23.09, 22.40, 19.96, 13.88 ppm. Water content: 890 ppm. Elemental analysis for C₁₇H₂₉F₆N₃O₄S₂ (M = 517.55 g mol⁻¹) calculated (%): C 39.45, H 5.65, N 8.12, S 12.39 and found (%): C 38.18, H 4.92, N 8.87, S 12.08.

Table S1. Ionogel structure and synthesis optimization.

No.	Ionic liquid		Polymer			Conditions
	[DBU- X]TFSI	IL in ionogel, %	(Monomer+Initiator)/ Ionogel, %	Monomer amount, %	Initiator amount, %	
1	None	0 %	PEGDA, 100 %	99.9	0.1 %	7'stirr, 5'UV, Air
2	None	0 %	PEGDA, 100 %	99	1.0 %	7'stirr, 5'UV, Air
3	None	0 %	TPPTA, 100 %	99	1.0 %	10'stirr, 5'UV, Air
4	None	0 %	PEGDA/TPPTA, 1/1, 100 %	99	1.0 %	10'stirr, 5'UV, Air
5.1	[DBU-C2]TFSI	0.1 %	PEGDA, 99.9 %	99	1.0 %	30'stirr, 5'UV, N ₂
5.2	[DBU-C2]TFSI	0.1 %	PEGDA, 99.9 %	99.9	1.0 %	30'stirr, 5'UV, N ₂
6.1	[DBU-C2]TFSI	1.0 %	PEGDA, 99 %	99	1.0 %	30'stirr, 5'UV, N ₂
6.2	[DBU-C2]TFSI	1.0 %	PEGDA, 99 %	99	1.0 %	30'stirr, 5'UV, N ₂
7.1	[DBU-C2]TFSI	5.0 %	PEGDA, 95 %	99	1.0 %	30'stirr, 5'UV, N ₂
7.2	[DBU-C2]TFSI	5.0 %	PEGDA, 95 %	99	1.0 %	30'stirr, 5'UV, N ₂
8.1	[DBU-C2]TFSI	10.0 %	PEGDA, 90 %	99	1.0 %	30'stirr, 5'UV, N ₂
8.2	[DBU-C2]TFSI	10.0 %	PEGDA, 90 %	99	1.0 %	30'stirr, 5'UV, N ₂
9.1	[DBU-C2]TFSI	50.0 %	PEGDA, 50 %	99	1.0 %	30'stirr, 5'UV, N ₂
9.2	[DBU-C2]TFSI	50.0 %	PEGDA, 50 %	99	1.0 %	30'stirr, 5'UV, N ₂
10.1	[DBU-C2]TFSI	40.0	PEGDA, 60 %	99	1.0 %	30'stirr, 5'UV, Air
10.2	[DBU-C2]TFSI	40.0	PEGDA, 60 %	99	1.0 %	30'stirr, 5'UV, Air
11.1	[DBU-C2]TFSI	40.0	PEGDA, 60 %	99	1.0 %	30'stirr, 5'UV, Air
11.2	[DBU-C2]TFSI	40.0	PEGDA, 60 %	99	1.0 %	30'stirr, 5'UV, Air

12.1	[DBU-C2]TFSI	40.0	PEGDA/TPPTA, 1/1, 60 %	99	1.0 %	30'stirr, 5'UV, Air
12.2	[DBU-C2]TFSI	40.0	PEGDA/TPPTA, 1/1, 60 %	99	1.0 %	30'stirr, 5'UV, Air
13.1	[DBU-C2]TFSI	40.0	PEGDA/TPPTA, 3/1, 60 %	99	1.0 %	30'stirr, 5'UV, Air
13.2	[DBU-C2]TFSI	40.0	PEGDA/TPPTA, 3/1, 60 %	99	1.0 %	30'stirr, 5'UV, Air
14.1	[DBU-C2]TFSI	40.0	PEGDA/TPPTA, 1/3, 60 %	99	1.0 %	30'stirr, 5'UV, Air
14.2	[DBU-C2]TFSI	40.0	PEGDA/TPPTA, 1/3, 60 %	99	1.0 %	30'stirr, 5'UV, Air
15.1	[DBU-C2]TFSI	40.0	PEGDA/TPPTA, 4/1, 60 %	99	1.0 %	30'stirr, 5'UV, Air
15.2	[DBU-C2]TFSI	40.0	PEGDA/TPPTA, 4/1, 60 %	99	1.0 %	30'stirr, 5'UV, Air
16.1	[DBU-C2]TFSI	40.0	PEGDA/TPPTA, 9/1, 60 %	99	1.0 %	30'stirr, 5'UV, Air
17.2	[DBU-C2]TFSI	40.0	PEGDA/TPPTA, 9/1, 60 %	99	1.0 %	30'stirr, 5'UV, Air
17.1	[DBU-C2]TFSI	15.0	PEGDA, 85 %	99	1.0 %	30'stirr, 5'UV, Air
18.2	[DBU-C2]TFSI	15.0	PEGDA, 85 %	99	1.0 %	30'stirr, 5'UV, Air
19.1	[DBU-C2]TFSI	20.0	PEGDA, 80 %	99	1.0 %	30'stirr, 5'UV, Air
19.2	[DBU-C2]TFSI	20.0	PEGDA, 80 %	99	1.0 %	30'stirr, 5'UV, Air
20.1	[DBU-C4]TFSI	10.0	PEGDA, 90 %	99	1.0 %	30'stirr, 5'UV, Air
20.2	[DBU-C4]TFSI	10.0	PEGDA, 90 %	99	1.0 %	30'stirr, 5'UV, Air
21.1	[DBU-C6]TFSI	10.0	PEGDA, 90 %	99	1.0 %	30'stirr, 5'UV, Air
21.2	[DBU-C6]TFSI	10.0	PEGDA, 90 %	99	1.0 %	30'stirr, 5'UV, Air

Ionogel preparation

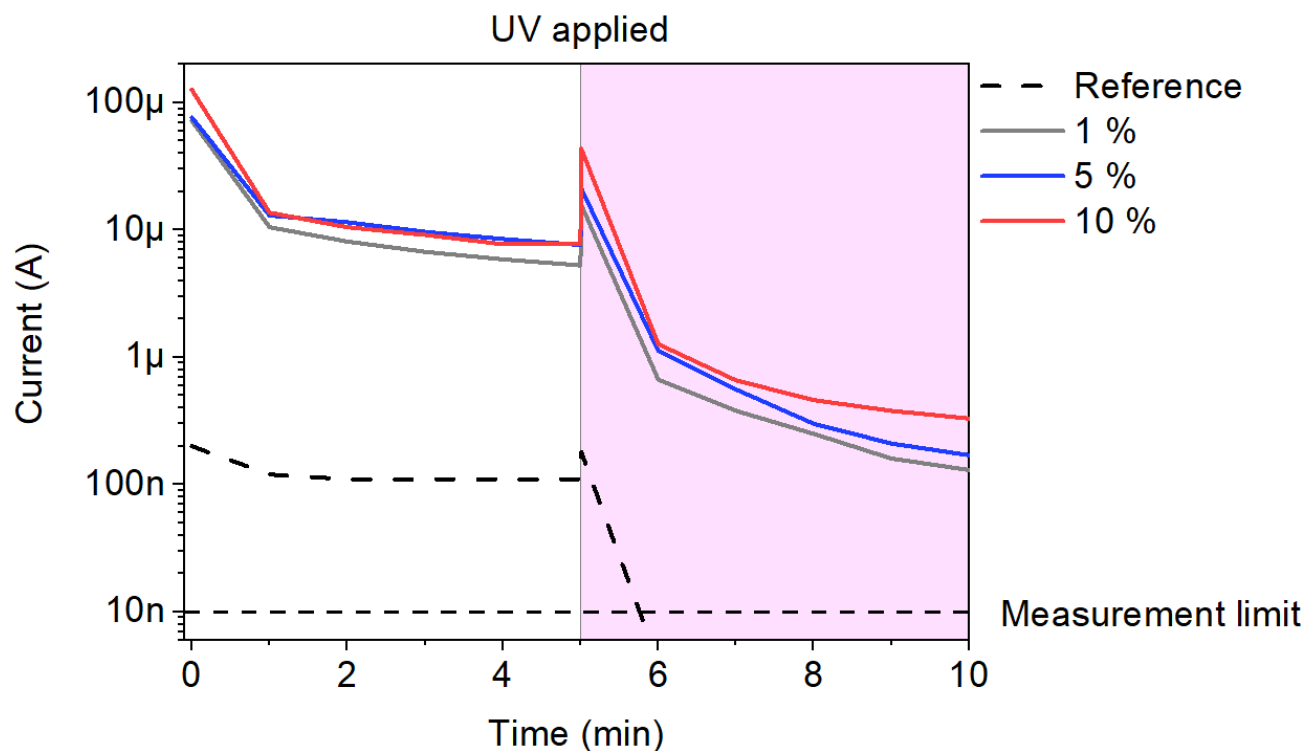


Figure S1: Polymer curing currents for reference, 1, 5 and 10 wt. % samples. UV is applied after 5 minutes.

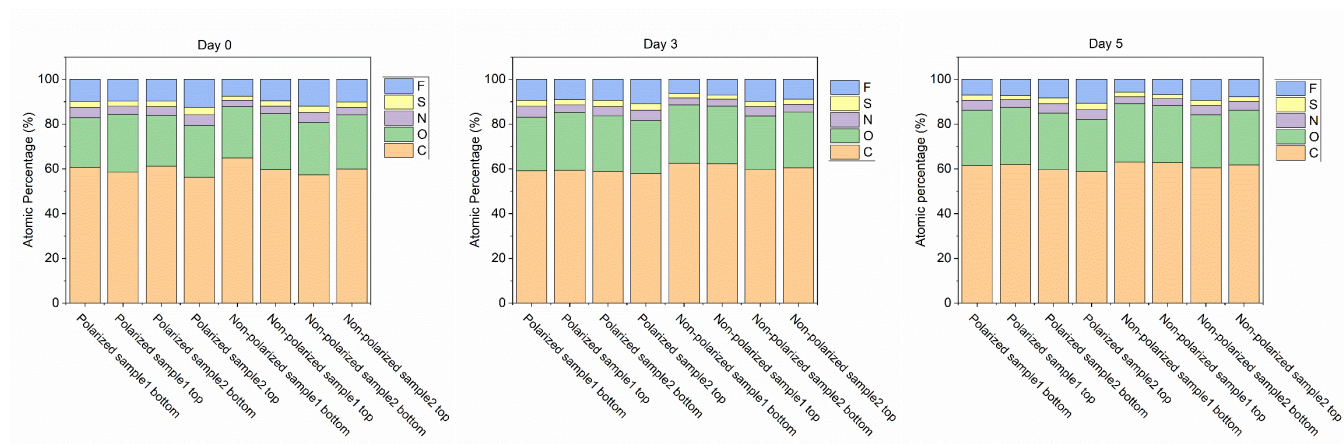


Figure S2: Surface elemental concentration of different electrets 10 wt. % [DBU-C4][TFSI] with and without polarization at 2.5 V potential measured with X-ray photoelectron spectroscopy (XPS).