

Article

Lactic Acid-Based Solvents for Sustainable EDLC Electrolytes

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Supplementary Materials

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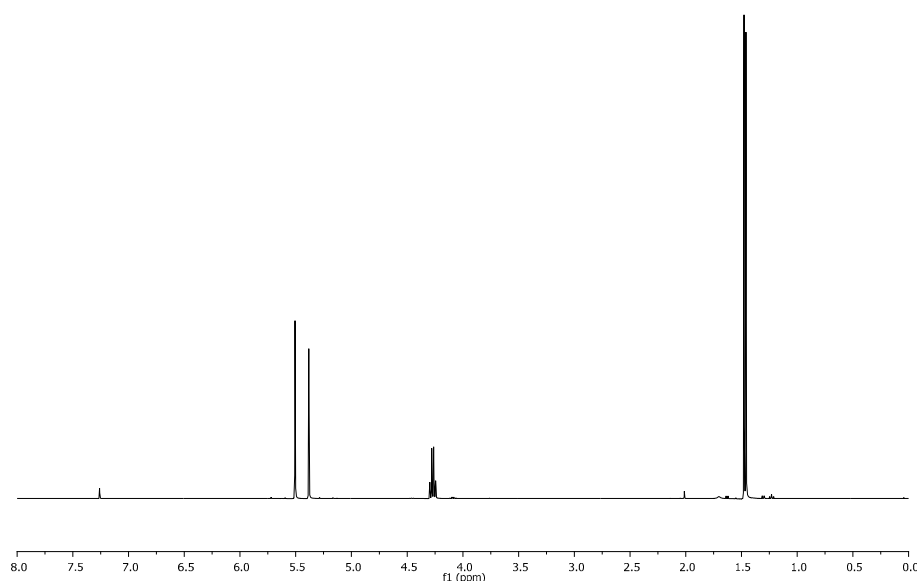


Figure S1. 5-methyl-1,3-dioxolan-4-one (LA-H,H) characterization. ¹H NMR (400 MHz, CDCl₃) δ 5.51 (s, 1H), 5.38 (s, 1H), 4.27 (q, *J* = 6.8, 1H), 1.47 (d, *J* = 6.8, 3H).

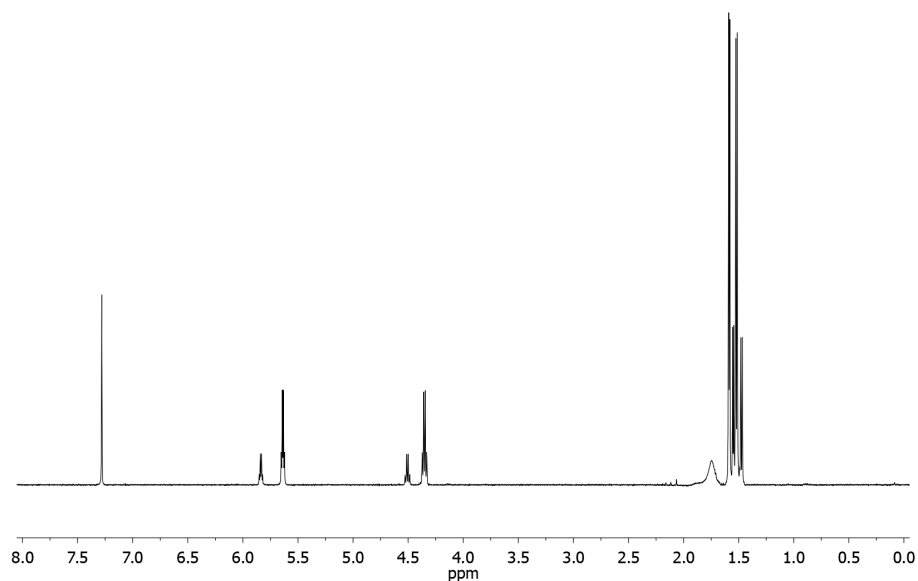


Figure S2. 5,2-dimethyl-1,3-dioxolan-4-one (LA-H,Me) characterization. Major stereoisomer: ^1H NMR (400 MHz, CDCl_3) δ 5.64 (q, 1H, $J = 5.0$ Hz), 4.35 (q, 1H, $J = 7.0$ Hz), 1.59 (d, 3H, $J = 5.0$ Hz), 1.52 (d, 3H, $J = 7.0$ Hz). Minor stereoisomer: ^1H NMR (400 MHz, CDCl_3) δ 5.84 (q, 1H, $J = 5.0$ Hz), 4.50 (q, 1H, $J = 7.0$ Hz), 1.55 (d, 3H, $J = 5.0$ Hz), 1.48 (d, 3H, $J = 7.0$ Hz).

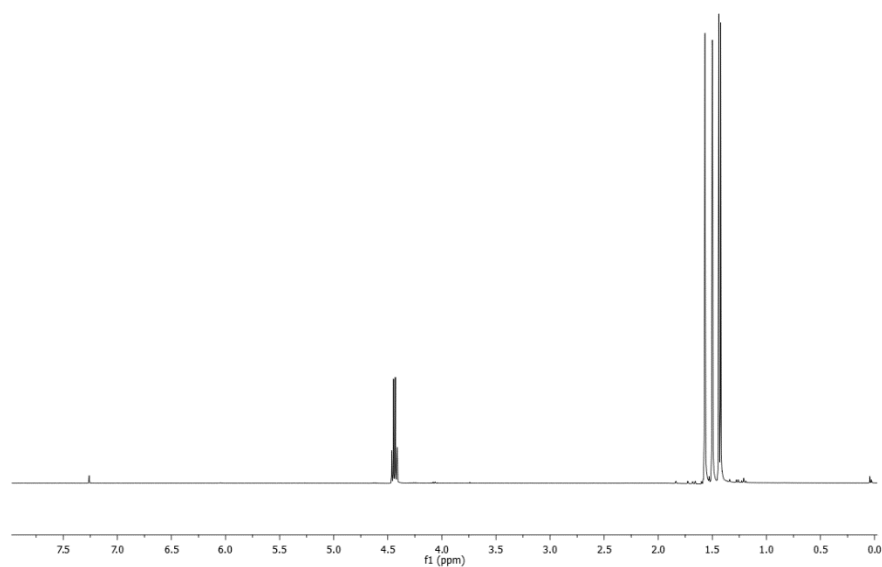


Figure S3. 5,2,3-trimethyl-1,3-dioxolan-4-one (LA-Me,Me) characterization. ^1H NMR (400 MHz, CDCl_3) δ 4.46 (q, $J = 6.8$ Hz, 1H), 1.59 (s, 3H), 1.52 (s, 3H), 1.46 (d, $J = 6.8$ Hz, 3H).

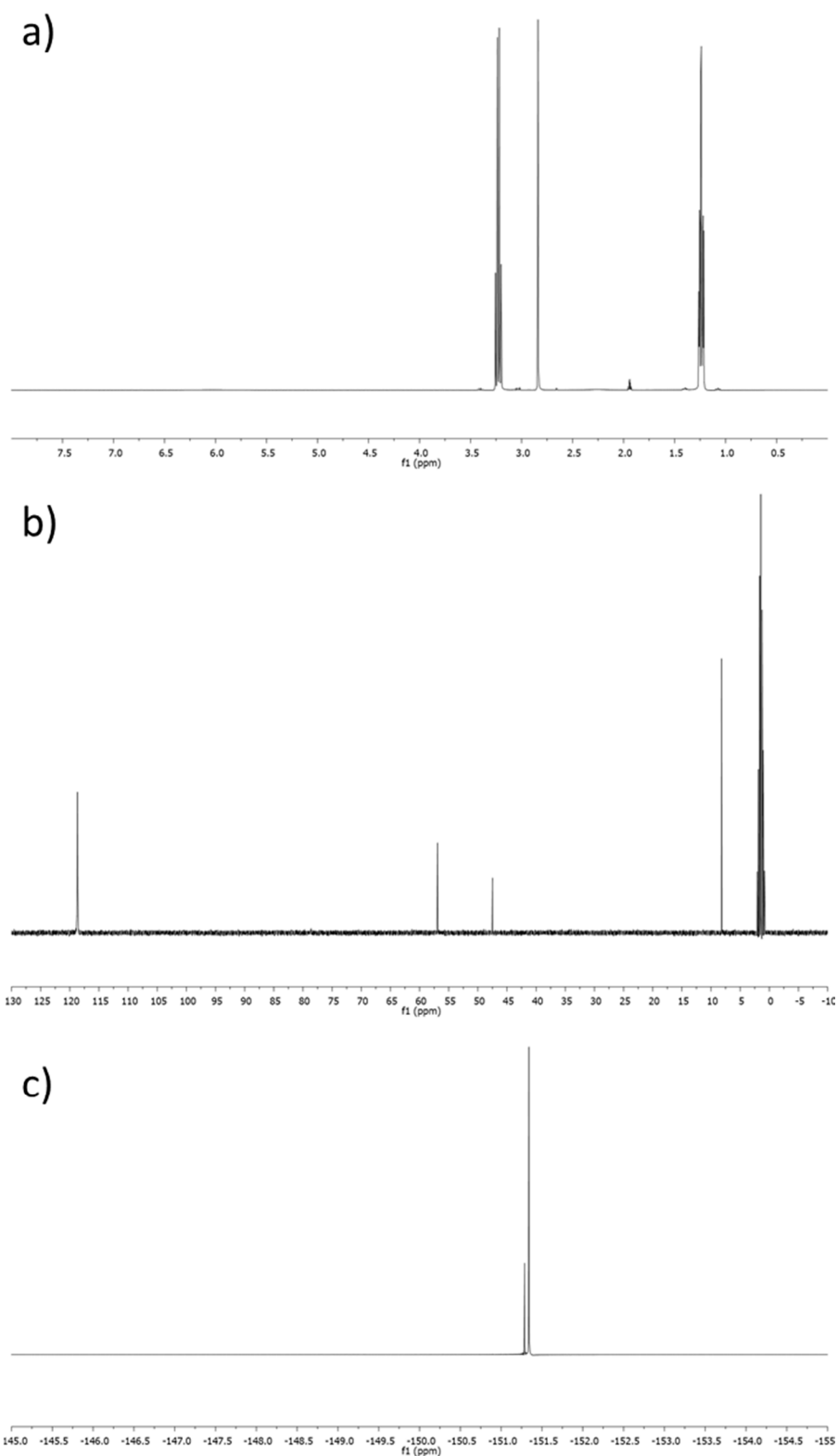


Figure S4. Triethylmethylammonium tetrafluoroborate (TEMABF₄) characterization. (a) ¹H NMR (400 MHz, CD₃CN) δ 3.23 (q, *J* = 7.3 Hz, 6H), 2.84 (s, 3H), 1.30 – 1.18 (t, *J*_N = 2 Hz, 9H). (b) ¹³C NMR (101 MHz, CD₃CN) δ 56.91 (t, *J*_N = 3 Hz), 47.48 (t, *J*_N = 4 Hz), 8.19. (c) ¹⁹F NMR (376 MHz, CD₃CN) δ -151.29 (¹⁰B), -151.34 (¹¹B).

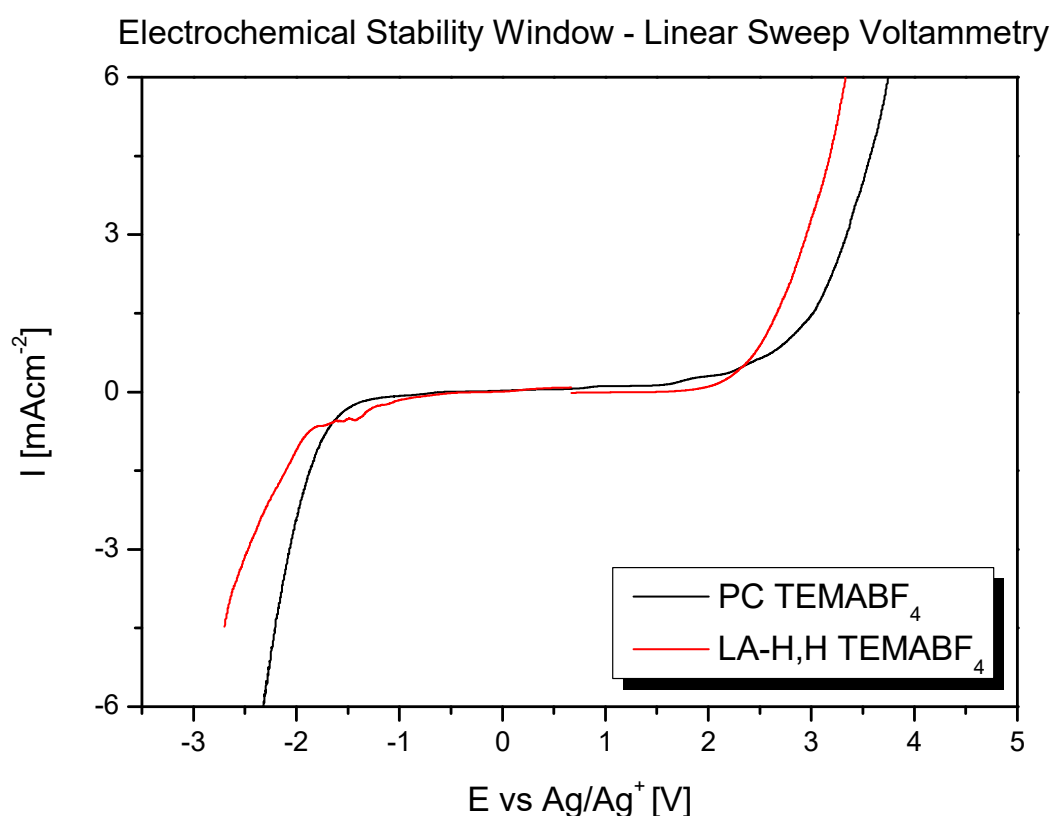


Figure S5. Electrochemical stability window analysis.

Table S1. ESW data at different current densities cut-off.

Electrolyte	0.5 mAcm ⁻²			1.0 mAcm ⁻²			1.5 mAcm ⁻²		
	E _{rid} (V)	E _{ox} (V)	ΔV	E _{rid} (V)	E _{ox} (V)	ΔV	E _{rid} (V)	E _{ox} (V)	ΔV
PC	-1.60	2.35	3.95	-1.75	2.80	4.55	-1.85	3.00	4.85
LA-H,H	-1.50	2.35	3.85	-1.95	2.55	4.50	-2.10	2.70	4.80

Table S2. Relevant performance from cited literature.

Entry [Ref]	Electrode	Electrolyte	Operative Voltage	Specific Energy*	Specific Power*	Stability
[1]	Active Carbon EDLC asymmetric	Non-aqueous CPAME ^d [Py ₁₄][BF ₄]	3.0 V	Not reported	Not reported	Float test 500 h at 3.0V Cap Ret 52.5%
[2]	Active Carbon EDLC	Organic CPAME [Et ₄ N][BF ₄]	3.5 V	Not reported	Not reported	Float test 500 h at 3.2V Cap Ret 78%
[3]	Active Carbon EDLC Monolithic	WiS LiTFSI 5 M	2.4 V	24 Whkg ⁻¹ 10 Whkg ⁻¹	0.48 kWkg ⁻¹ 7.6 kWkg ⁻¹	10,000 at 5 Ag ⁻¹ Cap Ret 81%
[4]	3D-CMF-EDA ^a Pseudocapacitor or	WiS NaTFSI 8.1 m	2.2 V	48.5 Whkg ⁻¹	4.9 kWkg ⁻¹	3000 at 5Ag ⁻¹ Cap Ret 90%
[5]	PD CNRs ^b EDLC	WiS LiTFSI 21 m	2.2 V	29.6 Whkg ⁻¹ 21.5 Whkg ⁻¹	1.1 kWkg ⁻¹ 10.9 kWkg ⁻¹	6000 at 5Ag ⁻¹ Cap Ret 99%

[6]	Active Carbon EDLC Coin cell	WiS NaClO ₄ 17 m	2.3 V	23.7 Whkg ⁻¹ 16.7 Whkg ⁻¹	1.1 kWkg ⁻¹ 20.7 kWkg ⁻¹	20,000 at 5Ag ⁻¹ Cap Ret 85%
[7]	AC EDLC	Microemulsion ^c	2.7 V	Not reported	1.35 kWkg ⁻¹ 5.4 kWkg ⁻¹	10,000 at 0.5Ag ⁻¹ Cap Ret 99%
[8]	AC EDLC asymmetric	WiS NH ₄ OAc 26.4 m	1.2 V	9.2 Whkg ⁻¹	0.45 kWkg ⁻¹	1000 at 1.0 Ag ⁻¹ Cap Ret < 95%

^a3D-CMF-EtOH: 3-dimensional-carbonized melamine foam-ethylendiammine as liquid component; ^bPolyaniline derived carbon nanoroads, ^cmicroemulsion 84% wt distilled water, 4% wt sodium dodecyl sulfate, 9% wt n-butanol, 3%wt ciclohexane; *data report at low and high current densities.

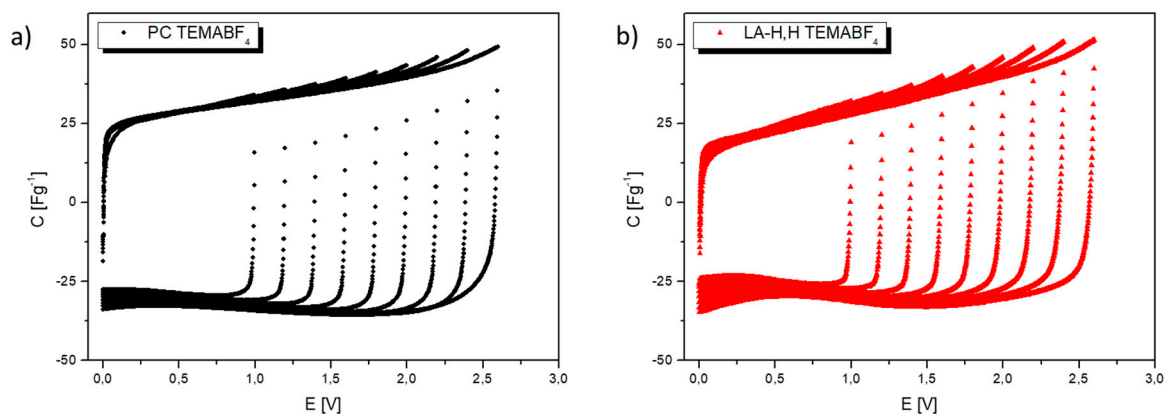


Figure S6. Operative voltage investigation.

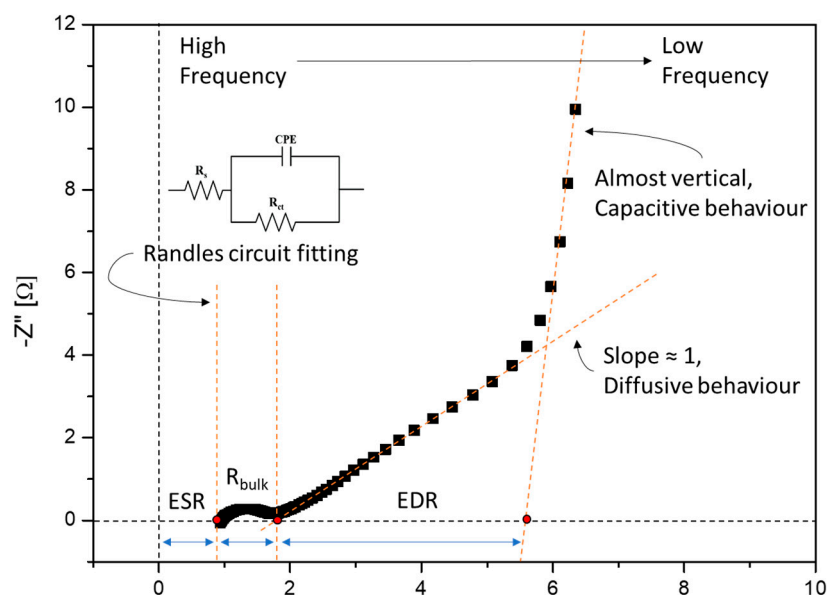


Figure S7. Nyquist plot analysis and resistances evaluations.

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