

Supplementary Materials

Sustainable and printable nanocellulose-based ionogels as gel polymer electrolytes for supercapacitors

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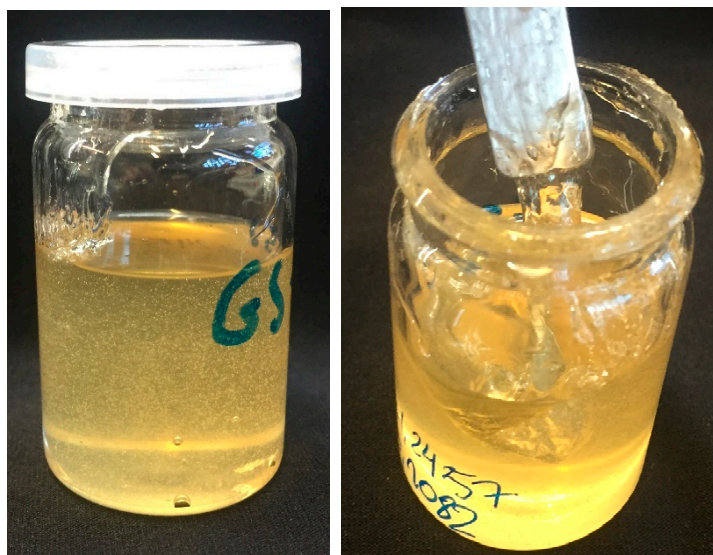


Figure S1: Final aspect of the as-prepared ionogels pictures.

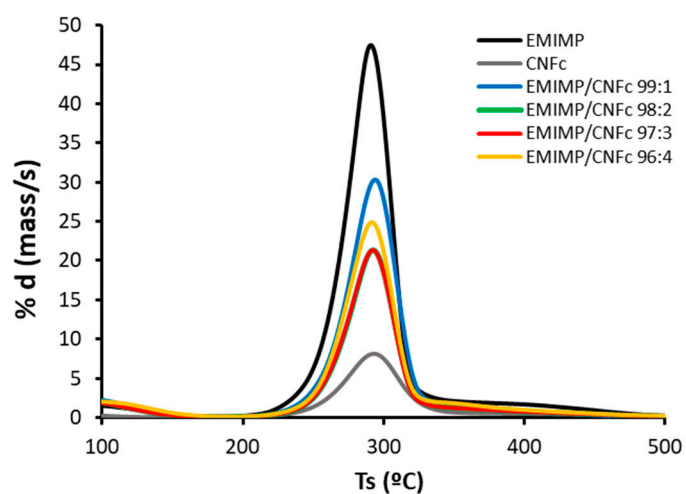


Figure S2: Differential scanning calorimetry thermogram (DSC) of the EMIMP/CNFc mixtures (99:1, 98:2, 97:3 and 96:4). Pristine CNFc and EMIMP were added for comparison purposes.

	EMIMP/NC ratio	T decomposition (°C)
EMIMP	100:0	290,0
CNFc	0:100	294,2
EMIMP/CNFc 99:1	99:1	292,0
EMIMP/CNFc 98:2	98:2	292,3
EMIMP/CNFc 97:3	97:3	292,7
EMIMP/CNFc 96:4	96:4	293,0

Table S1: Temperature decomposition for each EMIMP/CNFc mixtures (99:1, 98:2, 97:3 and 96:4) mixtures, obtained from differential scanning calorimetry thermograms (DSC). Pristine CNFc and EMIMP temperatures are also added.

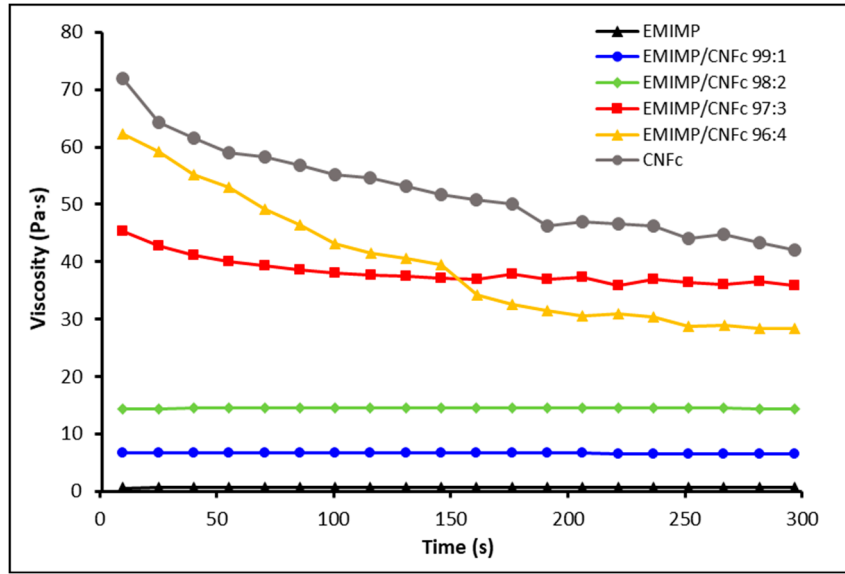


Figure S3: Rheological results at room temperature vs. time of the EMIMP/CNFc mixtures (99:1, 98:2, 97:3 and 96:4). Pristine CNFc and EMIMP are added for comparison purposes.

Electrolyte	i (mA/cm ²)	C _e (F g ⁻¹)	ESR (Ω cm ⁻²)	E _{max} (Wh kg ⁻¹)	P _{max} (W kg ⁻¹)
EMIMP	0.5	109±3	15±1	15.2±0.5	5872.2±490.3
	1	99± 4	14.7± 0.7	13.5±0.7	5924.9±485.5
	2	75±4	14.6±0.7	10.2±0.7	6003.3±475.9
	5	35±4	14.7±0.5	5.5±1.4	5974.7±473.5
	10	10±3	15.4±0.6	1.5±0.9	5908.8±764.1
EMIMP99:1	0.5	159±7	11±2	22.7±1.2	9536.2±2219.8
	1	132± 4	8.2± 0.8	18.7±0.7	11,280.3±2169.9
	2	105±3	7.7±0.8	14.4±0.5	11,796.8±2093.7
	5	59±6	8.4±0.6	7.9±1.1	11,155.5±2209.7
	10	29±7	7.9±0.8	3.6±1.1	10,934±1987
EMIMP98:2	0.5	174±9	11±4	24.1±1.6	7618.5±2107.4
	1	156± 11	10± 2	21.5±1.8	8132.8±2364.1
	2	127±15	9±2	17.8±2.5	8311.8±2479.6
	5	73±21	10±2	10.3±3.6	8107.3±2487.9
	10	30±16	10±2	4.2±2.7	7695±2462
EMIMP97:3	0.5	172±6	12±1	24.0±1.2	7677.7±938
	1	160± 6	10.2± 0.7	22.3±1.2	8841.9±790.6
	2	139±9	9.7±0.5	19.3±1.8	9330±659
	5	93±12	9.6±0.3	12.9±2.4	9332.7±350.2
	10	44±9	10.2±0.2	6.2±1.8	8823±525
EMIMP96:4	0.5	165±4	7.4±0.5	22.5±0.8	12,717±986
	1	152± 5	5.6± 0.6	20.8±0.9	16,023±1524
	2	130±8	5.3±0.3	18.1±1.3	16,729.1±1723.5
	5	91±12	5.4±0.2	13.3±2.0	16,429.1±1767.6
	10	56±11	5.7±0.3	8.5±1.8	15,463.4±1415.7

Table S2: Summary of the key performance parameters on different current density such as specific capacitance, ESR, E_{\max} and P_{\max}

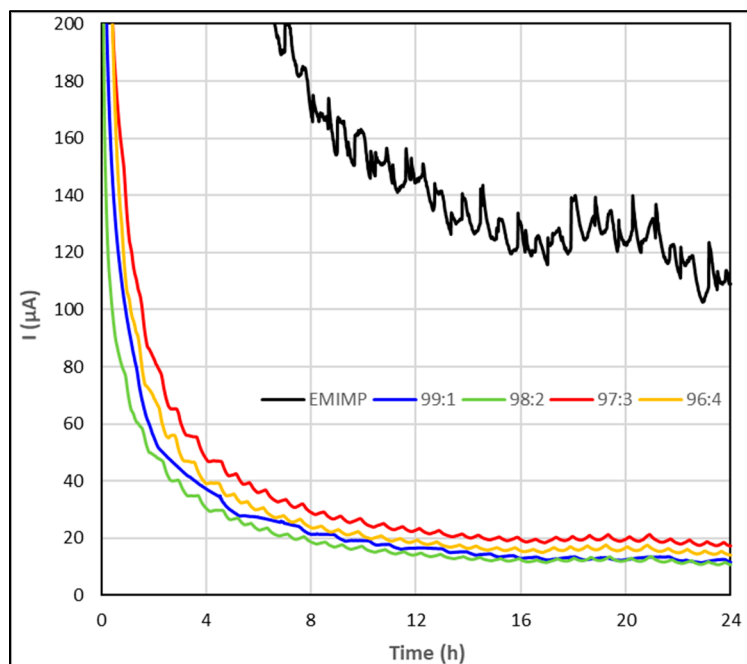


Figure S4: Current (μA) vs. time for supercapacitors with EMIMP and EMIMP/CNFc (99:1, 98:2, 97:3 and 96:4) as electrolytes for a period of 24h

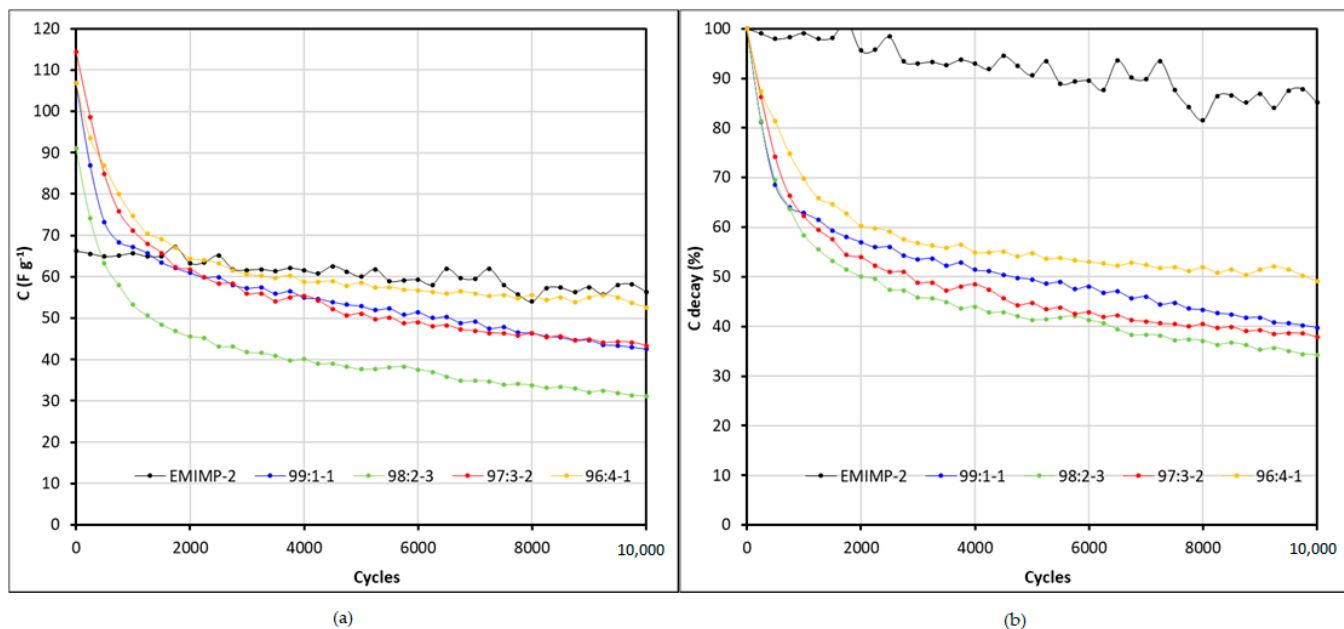


Figure S5: The capacity variation with the cycles and for supercapacitors with EMIMP and EMIMP/CNFc (99:1, 98:2, 97:3 and 96:4) as electrolytes.

Electrolyte	i (mA/cm ²)	C _e (F g ⁻¹)	ESR (Ω cm ⁻²)
EMIMP/CMC	0.5	153±3	11.8±1
	1	123± 4	10.6± 0.7
	2	96±4	10.3±0.7
	5	54±4	10.4±0.5
	10	23±3	10.6±0.6
EMIMP99:1	0.5	159±7	11±2
	1	132± 4	8.2± 0.8
	2	105±3	7.7±0.8
	5	59±6	8.4±0.6
	10	29±7	7.9±0.8

Table S3: Summary of the key performance parameters on different current density such as specific capacitance and ESR of EMIMP/CMC vs EMIMP/CNFc 99:1

	Scan rate (mV s ⁻¹)	C _e (F g ⁻¹)
EMIMP	10	2.4
	50	0.6
EMIMP99:1	10	6.9
	50	1.1
EMIMP98:2	10	8.1
	50	1.1
EMIMP97:3	10	8.3
	50	1.2
EMIMP96:4	10	7.3
	50	1.1

Table S4: Summary of specific capacitance of EMIMP and ionogels with different ratio of CNF_c at 10 mV s⁻¹ and 50 mV s⁻¹

scan rate for CV

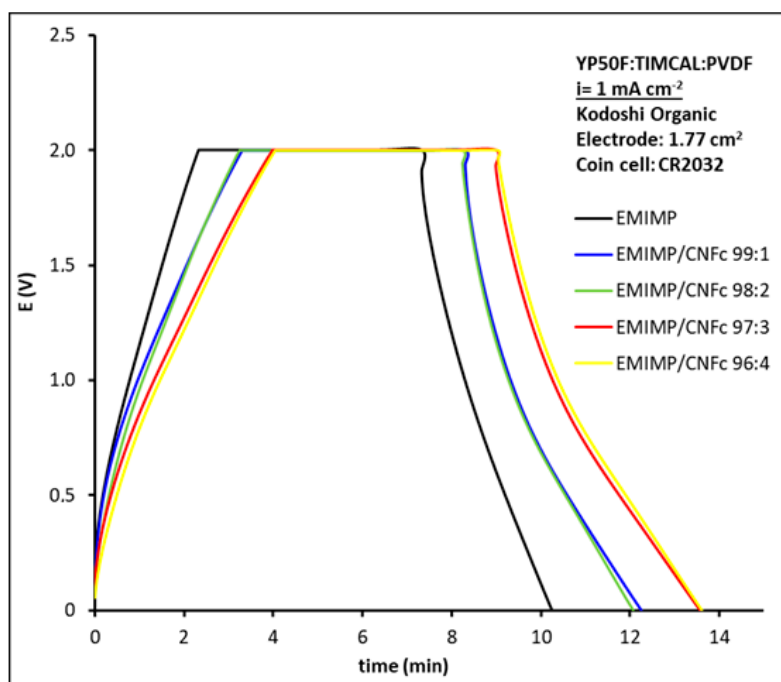


Figure S6: Galvanostatic charge-discharge curve of EMIMP and ionogels with different ratio of CNFc at $i = 1 \text{ mA cm}^{-2}$

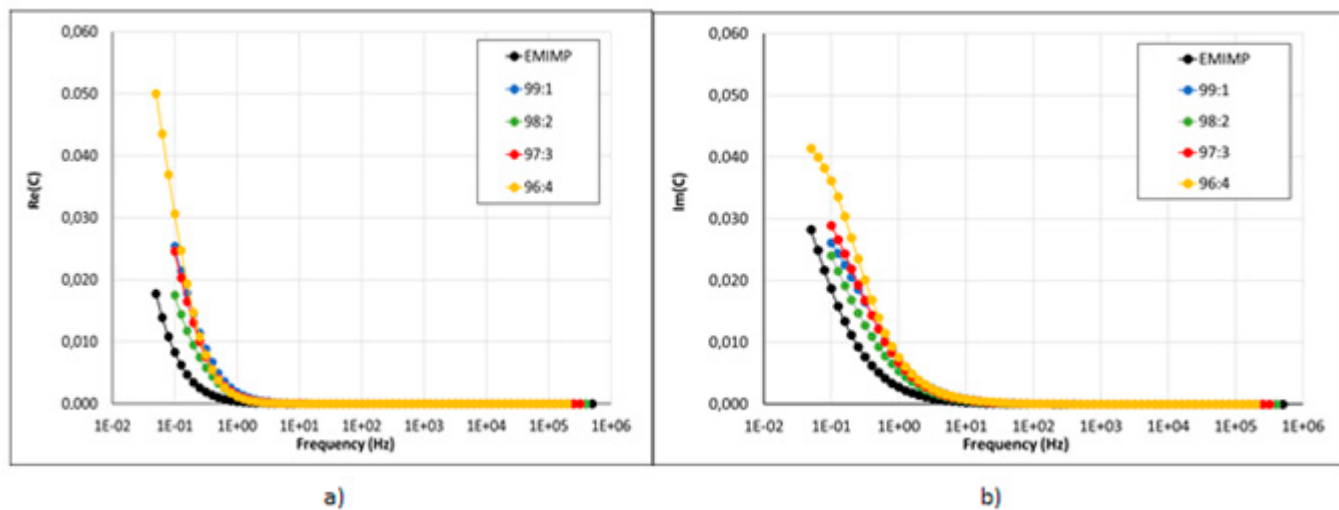


Figure S7: a) Real part of the capacitance vs Frequency and b) Imaginary part of the capacitance versus Frequencies of EMIMP and ionogels with different ratio of CNFc