

## Supplementary Information

### Effect of the nature of the electrolyte on the behaviour of supercapacitors based on transparent $\text{ZnMn}_2\text{O}_4$ thin films

Juan José Peinado-Pérez<sup>a</sup>, María Cruz Lopez-Escalante<sup>b</sup>, Francisco Martín<sup>b\*</sup>

<sup>a</sup>Department of Applied Physics I. Faculty of Sciences, University of Málaga, Campus de Teatinos, E-29071. Málaga (Spain).

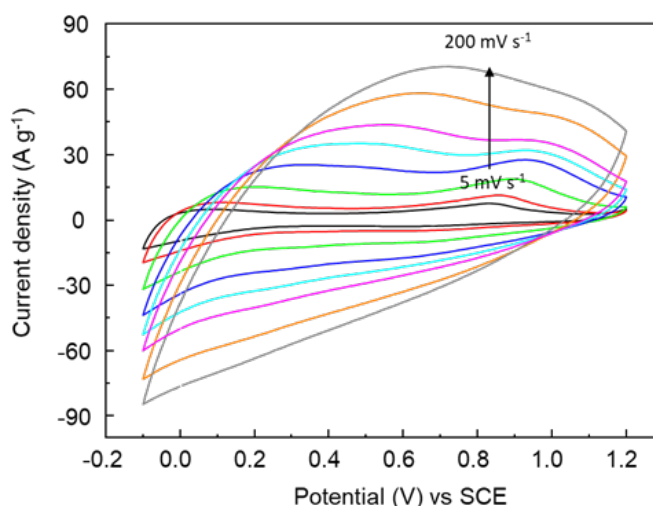
<sup>b</sup>Department of Chemical Engineering, Faculty of Sciences, University of Málaga, Campus de Teatinos, E-29071 Málaga, Spain. (\* corresponding author [marjim@uma.es](mailto:marjim@uma.es))

#### 1. Optical properties

Sample	Visible transmittance (from 380 to 770 nm) D65	Solar transmittance (from 295 to 2415 nm)	Colorimetric coordinates CIE 1931	Colorimetric coordinates CIELAB (1976, 2°, D65)
ITO	0.82	0.79	Y=81.81, x=0.31, y=0.32	L* = 92.49, a* =1.03, b* =-3.01
ITO/ $\text{ZnMn}_2\text{O}_4$ (2 min)	0.72	0.71	Y=71.29, x=0.33, y=0.35	L* = 87.83, a* =-1.16, b* =8.73
ITO/ $\text{ZnMn}_2\text{O}_4$ (5 min)	0.57	0.63	Y=56.6, x=0.35, y=0.36	L* = 79.95, a* =0.71, b* =16.62
ITO/ $\text{ZnMn}_2\text{O}_4$ (15 min)	0.30	0.48	Y=30.49, x=0.4, y=0.4	L* = 62.07, a* =5.72, b* = 30.81

Table SI 1: Visible and solar transmittance values, and colorimetric coordinates

#### 2. Three-electrode electrochemical cell characterization of $\text{ZnMn}_2\text{O}_4$ electrodes Figure SI 1:



Three-electrode cyclic voltammogram curves at different scan rates: 5, 10, 25, 50, 75, 100, 150 and 200  $\text{mV s}^{-1}$ .

Deposition method	Electrode	Electrolyte	Specific capacitance (F g <sup>-1</sup> )	Capacitance retention (%)	Energy density (W h kg <sup>-1</sup> )	Power density (W kg <sup>-1</sup> )	Reference
Pneumatique Spray deposition	ZnMn <sub>2</sub> O <sub>4</sub>	1M Na <sub>2</sub> SO <sub>4</sub>	752 (0.5A g <sup>-1</sup> ) 693 (5 mV s <sup>-1</sup> )	70% after 3000 cycles	1-8	300-1000	This study
	ZnMn <sub>2</sub> O <sub>4</sub>	2M KOH	155 (2 mV s <sup>-1</sup> )	*	*	*	[45]
Hydrothermal method	ZnMn <sub>2</sub> O <sub>4</sub>	1M KCl	675 (5 mV s <sup>-1</sup> )	61.7 % after 1000 Cycles	*	*	[74]
	ZnMn <sub>2</sub> O <sub>4</sub>	1M Na <sub>2</sub> SO <sub>4</sub>	87 (1 mV s <sup>-1</sup> )	60 % after 1000 Cycles	*	*	[75]
	ZnMn <sub>2</sub> O <sub>4</sub>	2 M KOH	54 (20 mV s <sup>-1</sup> )	*	*	*	[76]
	ZnMn <sub>2</sub> O <sub>4</sub>	2 M KOH	776 (5 mV s <sup>-1</sup> )	91 % after 5000 cycles	*	*	[77]
Combustion method	Carbon-ZnMn <sub>2</sub> O <sub>4</sub>	Na <sub>2</sub> SO <sub>4</sub>	150 (2 mV s <sup>-1</sup> )	60 % after 10000 cycles	*	*	[2]
	ZnMn <sub>2</sub> O <sub>4</sub>	2 M KOH	160 (3 mV s <sup>-1</sup> )	100% after 500 cycles	18	185	[70]
Ultrasonication	ZnMn <sub>2</sub> O <sub>4</sub> -Mn <sub>2</sub> O <sub>3</sub>	2 M KOH	380 (0.5 A g <sup>-1</sup> )	92 % after 2000 cycles	*	*	[78]
* Non data available							

Table SI 2: Values of specific capacitance obtained by different authors

## References

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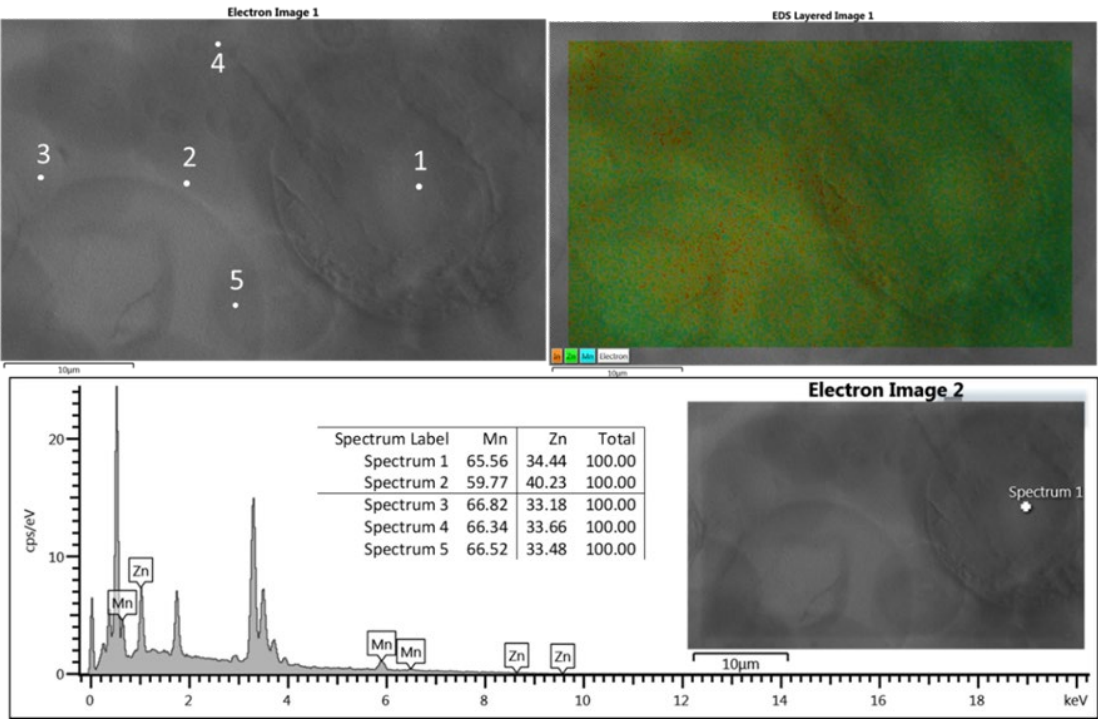


Figure SI 2: Example of EDS spectrum of the  $\text{ZnMn}_2\text{O}_4$  electrode as obtained, and atomic percentages of Mn and Zn.

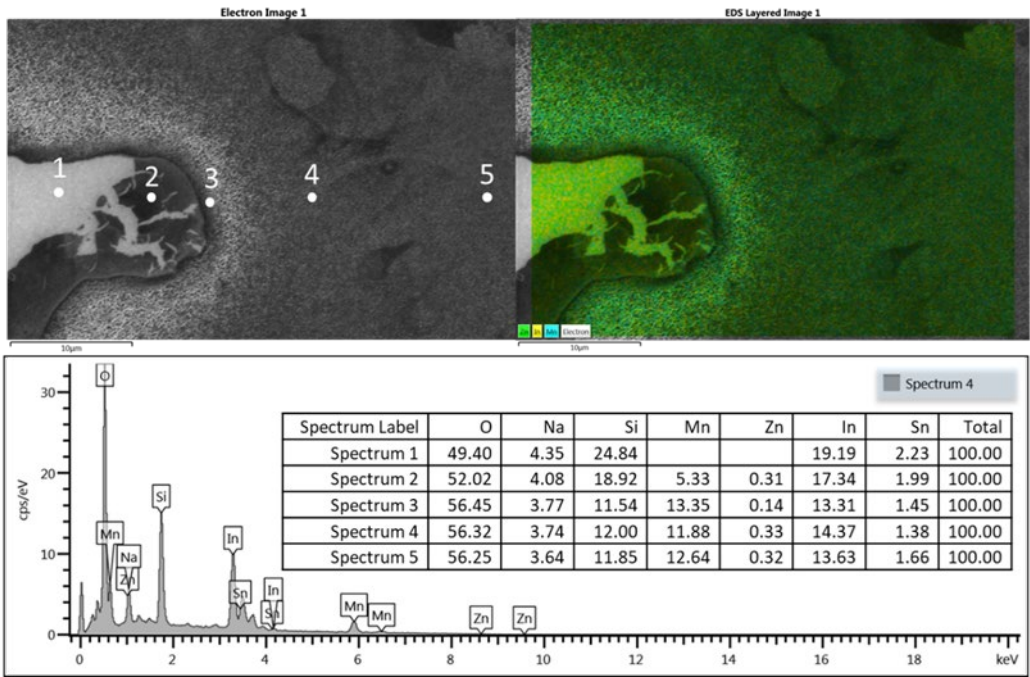


Figure SI 3: Example of EDS spectrum of the  $\text{ZnMn}_2\text{O}_4$  electrode after 3000 CV cycles and local values of the atomic percentage of the different chemical elements.

### 3. SCC, 1 M Na<sub>2</sub>SO<sub>4</sub> electrolyte

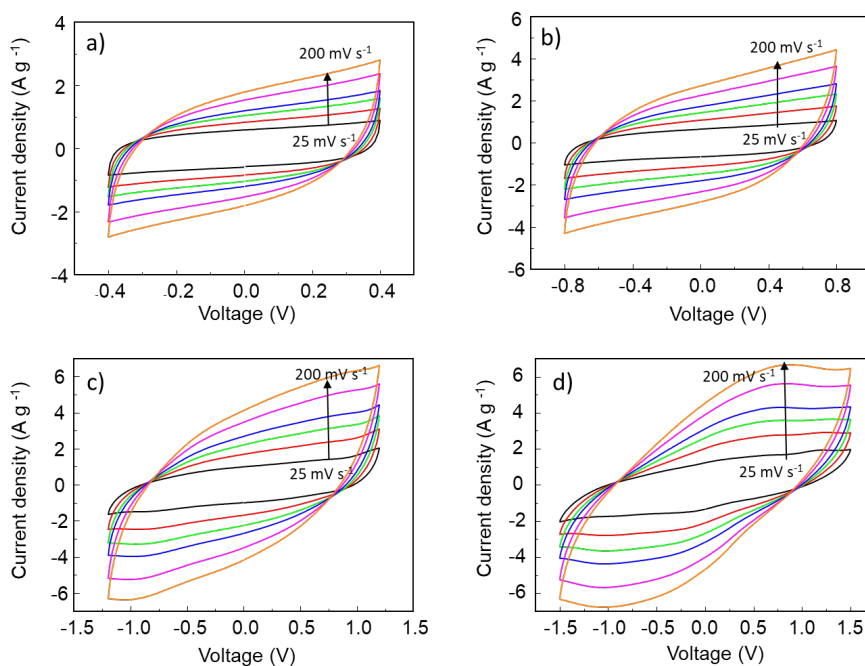


Figure SI 4: Cyclic voltammetry curves of SSC assembled with 1 M Na<sub>2</sub>SO<sub>4</sub>. (a)  $\pm 0.4$  V; (b)  $\pm 0.8$  V; (c)  $\pm 1.2$  V; (d)  $\pm 1.5$  V with different scan rates: 25 mV s<sup>-1</sup>, 50 mV s<sup>-1</sup>, 75 mV s<sup>-1</sup>, 100 mV s<sup>-1</sup>, 150 mV s<sup>-1</sup> and 200 mV s<sup>-1</sup>.

(a)					
Specific capacitance (Fg <sup>-1</sup> )	Scan rate (mVs <sup>-1</sup> )	Potential window (V)			
		$\pm 0.4$	$\pm 0.8$	$\pm 1.2$	$\pm 1.5$
1M Na <sub>2</sub> SO <sub>4</sub>	25	21	23	33	39
	50	15	19	28	30
	75	12	17	24	26
	100	10	15	21	23
	150	9	13	18	20
	200	8	11	16	17

(b)					
Electrolyte	Current Density (A g <sup>-1</sup> )	Time discharge (s)	Specific Capacitance (F g <sup>-1</sup> )	Energy density (Wh kg <sup>-1</sup> )	Power density (W kg <sup>-1</sup> )
1M Na <sub>2</sub> SO <sub>4</sub>	0.5	40	17	3.4	306
	1.0	8	7	1.4	630
	2.0	1	2	0.4	1440

Table SI 3. (a) Specific capacitance, energy and power density calculated from cyclic voltammetry; (b) GCD measurements of the SSC assembled with 1.0 M Na<sub>2</sub>SO<sub>4</sub> electrolyte

#### 4. SCC, PVP-Ionic Liquid electrolyte

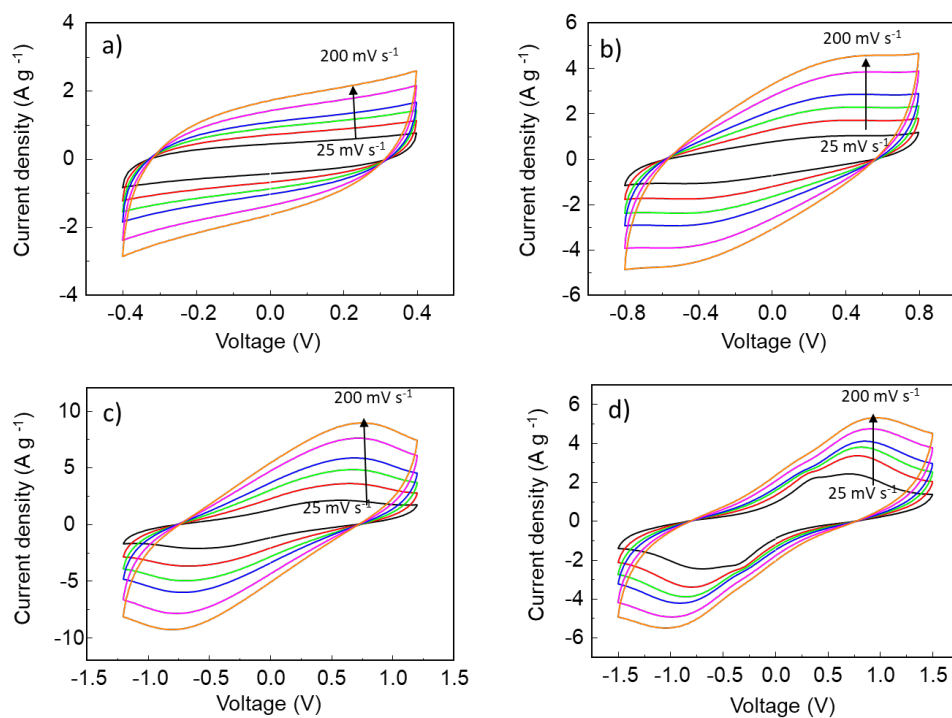


Figure SI 5. Cyclic voltammetry curves of SCC assembled with PVP-Ionic Liquid. (a)  $\pm 0.4$  V; (b)  $\pm 0.8$  V; (c)  $\pm 1.2$  V; (d)  $\pm 1.5$  V with different scan rates:  $25 \text{ mV s}^{-1}$ ,  $50 \text{ mV s}^{-1}$ ,  $75 \text{ mV s}^{-1}$ ,  $100 \text{ mV s}^{-1}$ ,  $150 \text{ mV s}^{-1}$  and  $200 \text{ mV s}^{-1}$ .

(a)					
Specific capacitance ( $\text{Fg}^{-1}$ )	Scan rate ( $\text{mVs}^{-1}$ )	Potential window (V)			
		$\pm 0.4$	$\pm 0.8$	$\pm 1.2$	$\pm 1.5$
PVP-Ionic Liquid	25	15	23	40	37
	50	11	20	35	29
	75	10	18	31	20
	100	9	16	28	16
	150	8	14	24	13
	200	7	13	21	11
(b)					
Electrolyte	Current Density ( $\text{A g}^{-1}$ )	Time discharge (s)	Specific Capacitance ( $\text{F g}^{-1}$ )	Energy density ( $\text{Wh kg}^{-1}$ )	Power density ( $\text{W kg}^{-1}$ )
PVP-Ionic Liquid	0.5	35	15	3.0	309
	1.0	6	5	1.0	600
	2.0	2	3	0.6	1080

Table SI 4. (a) Specific capacitance, energy and power density calculated from cyclic voltammetry, (b) GCD measurements, of the SCC assembled with PVP-Ionic Liquid.

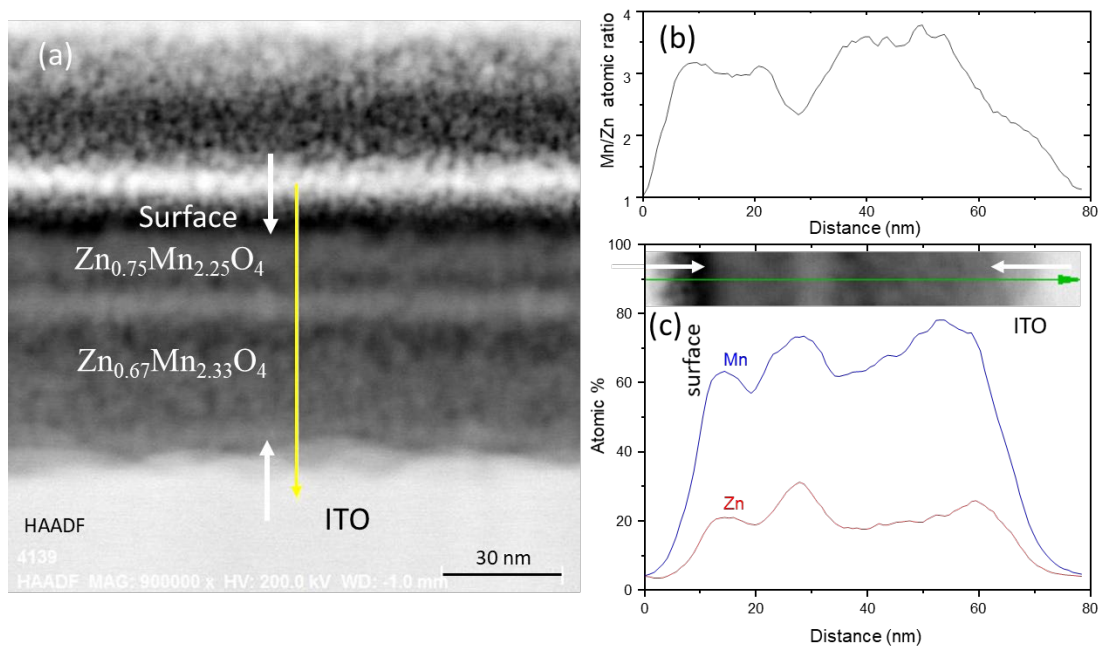
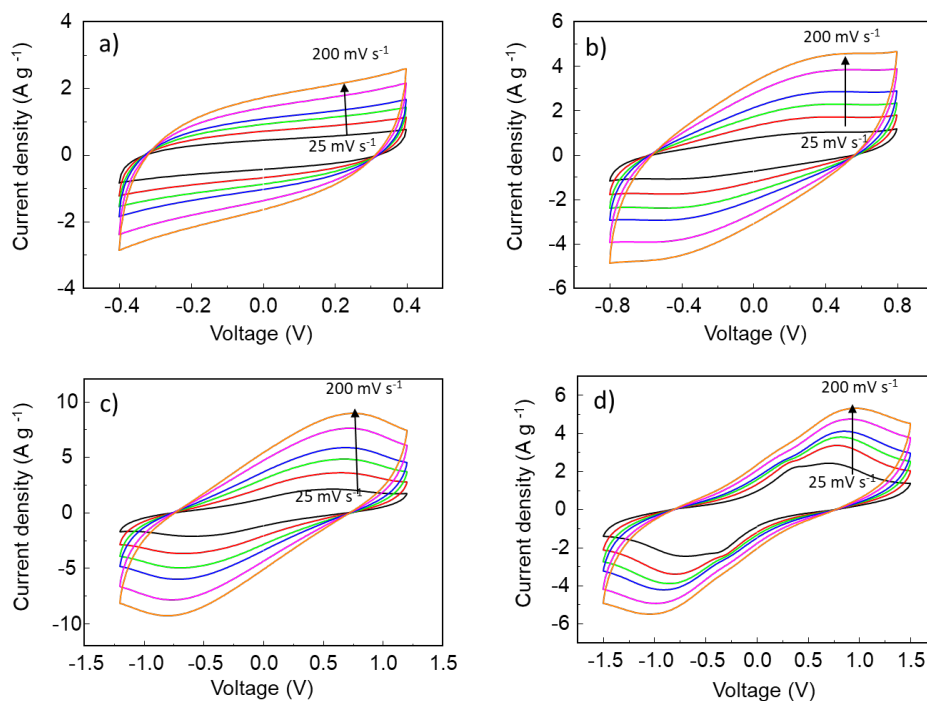


Figure SI 6: (a) HAADF image EDS of the cross-section of the SCC (PVP-Ionic Liquid) electrode after 300 CV cycles; (b) Mn/Zn atomic ratio and (c) atomic percentages of Mn and Zn, along the line marked on the HAADF image.

## 5. SCC, PVP- $\text{LiClO}_4$ electrolyte

Figure SI 7. Cyclic voltammetry curves of SSC assembled with PVP-Ionic Liquid. (a)  $\pm 0.4$  V; (b)  $\pm 0.8$  V; (c)  $\pm 1.2$  V; (d)



$\pm 1.5$  V with different scan rates: 25  $\text{mV s}^{-1}$ , 50  $\text{mV s}^{-1}$ , 75  $\text{mV s}^{-1}$ , 100  $\text{mV s}^{-1}$ , 150  $\text{mV s}^{-1}$  and 200  $\text{mV s}^{-1}$ .

(a)					
Specific capacitance ( $\text{F g}^{-1}$ )	Scan rate ( $\text{mVs}^{-1}$ )	Potential window (V)			
		$\pm 0.4$	$\pm 0.8$	$\pm 1.2$	$\pm 1.5$
PVP-LiClO <sub>4</sub>	25	13	17	22	19
	50	12	16	19	16
	75	11	15	17	14
	100	10	14	15	12
	150	10	14	14	11
	200	9	13	13	10

(b)					
Electrolyte	Current Density ( $\text{A g}^{-1}$ )	Time discharge (s)	Specific Capacitance ( $\text{F g}^{-1}$ )	Energy density ( $\text{Wh kg}^{-1}$ )	Power density ( $\text{W kg}^{-1}$ )
PVP-LiClO <sub>4</sub>	0.5	94	39	7.8	299
	1.0	38	31	6.2	587
	2.0	13	21	4.2	1163

Table SI 5. (a) Specific capacitance, energy and power density calculated from cyclic voltammetry; (b) galvanostatic charge-discharge measurements of the SSC assembled with PVP-LiClO<sub>4</sub>.

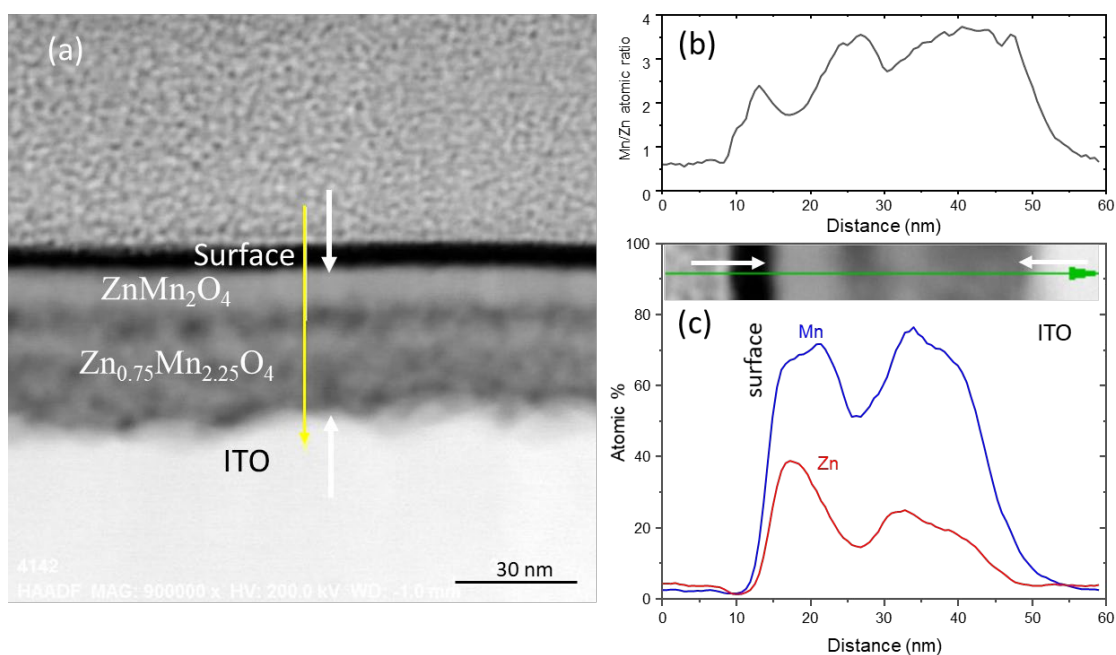


Figure S8: (a) HAADF image EDS of the cross-section of the SCC electrode (PVP-LiClO<sub>4</sub>) after 300 CV cycles; (b) Mn/Zn atomic ratio and (c) atomic percentages of Mn and Zn, along the line marked on the HAADF image



## 6. SEM images of the SSCs electrodes after CV cycling

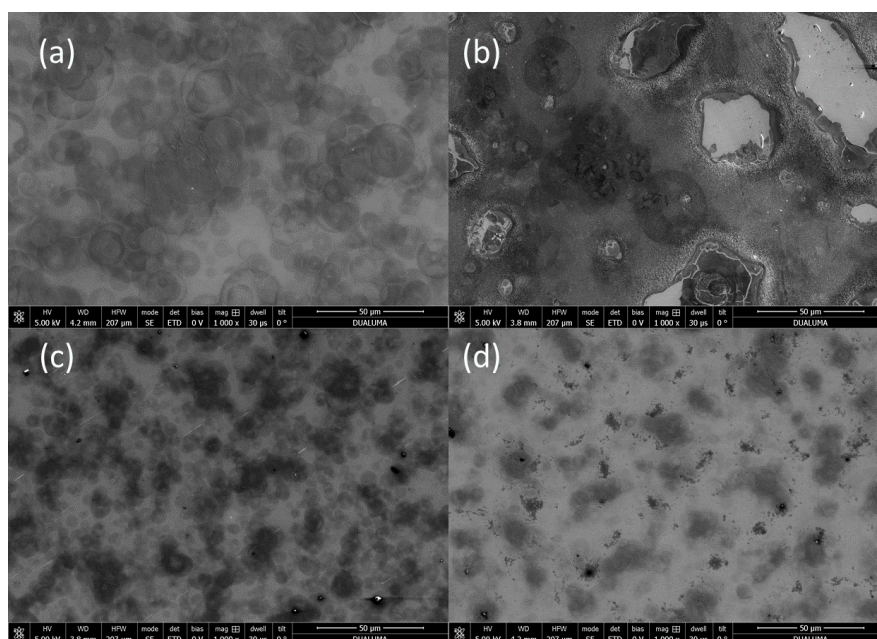


Figure SI 9: (a) SEM images of the surface of the electrode as obtained. SEM images of the surface of the SSC electrode after 300 CV cycles using as electrolyte: (b) 1.0 M  $\text{Na}_2\text{SO}_4$ , (c) PVP-Ionic Liquid, (d) PVP- $\text{LiClO}_4$ .