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Electronic Supplementary Information

High temperature-functioning ceramic-based ionic liquid electrolyte engraved planar HAp/PVP/MnO_2@$MnCO_3$ supercapacitors on carbon cloth

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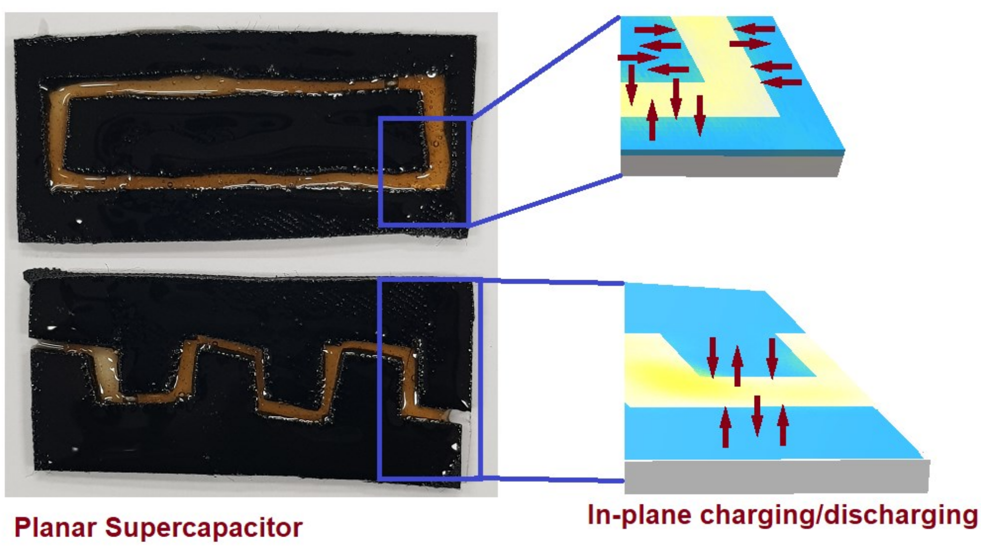
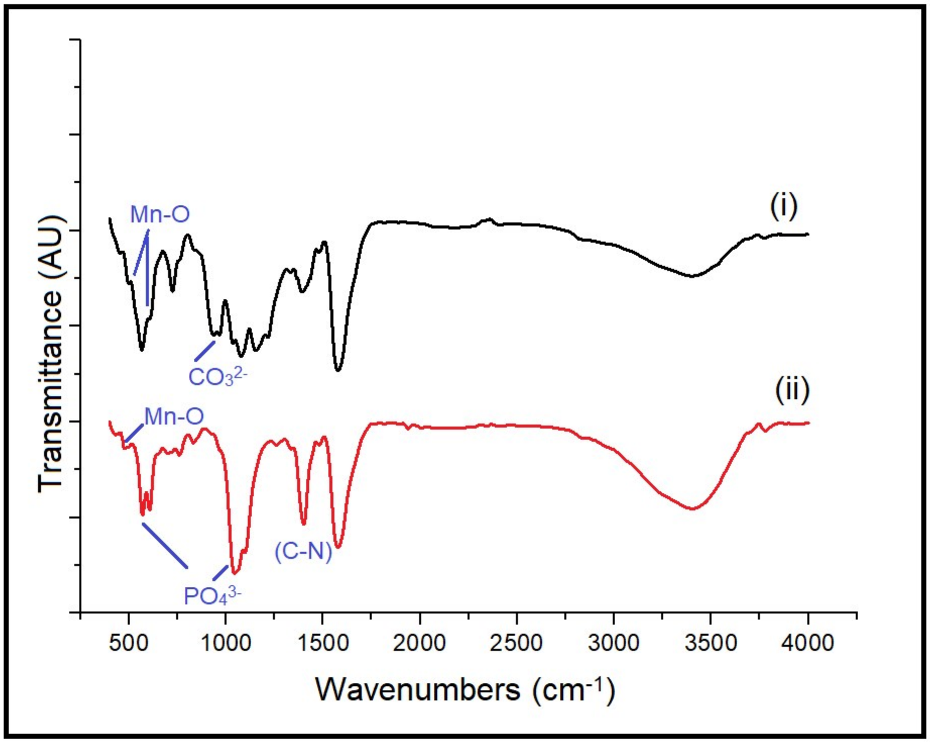


ESI Fig. 1. Schematic illustration of ion migration pathways in planar supercapacitor.

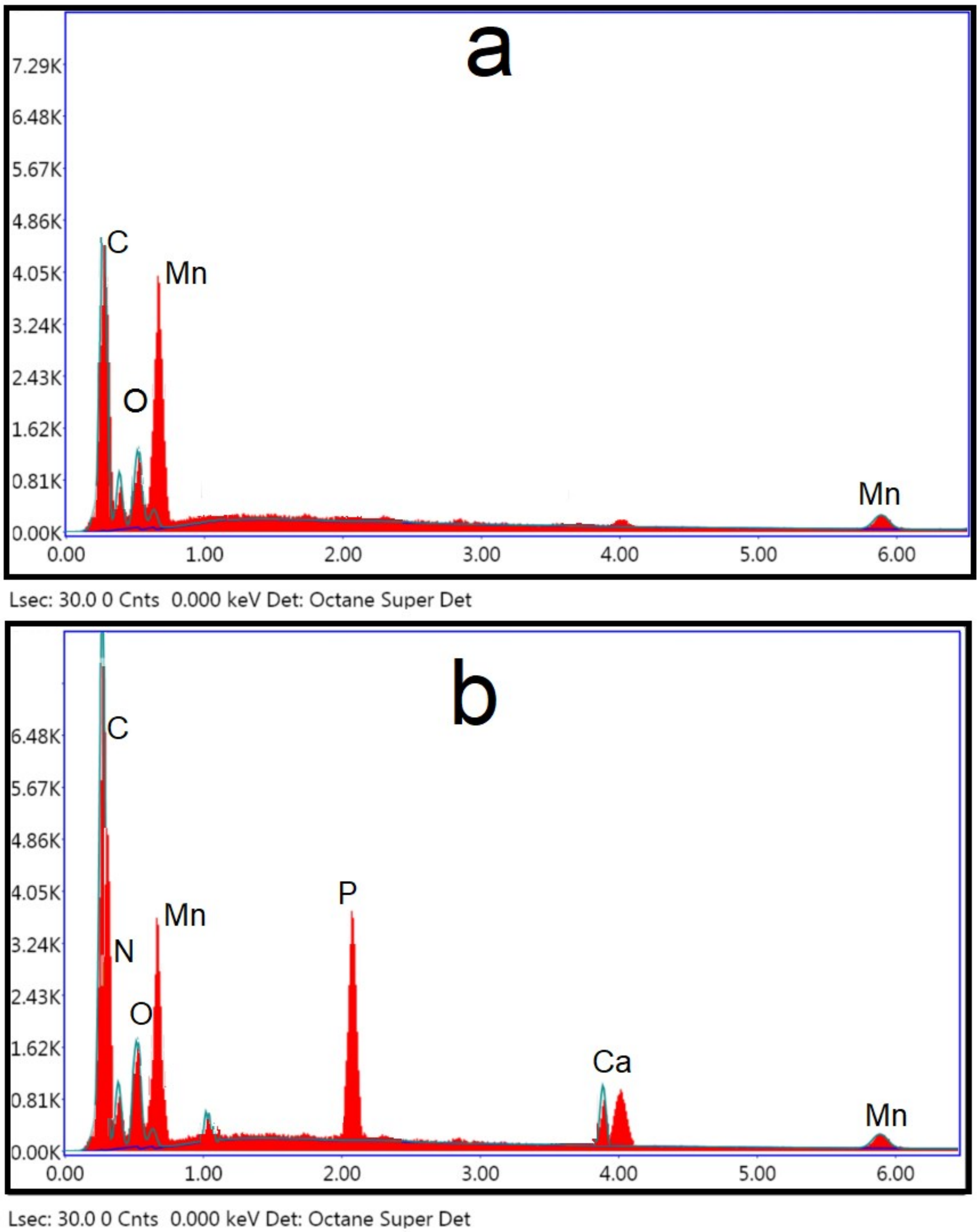


ESI Fig. 2. FTIR spectra of MnO_2@$MnCO_3$ (i) and HAp/PVP/ MnO_2@$MnCO_3$ (ii) composite.

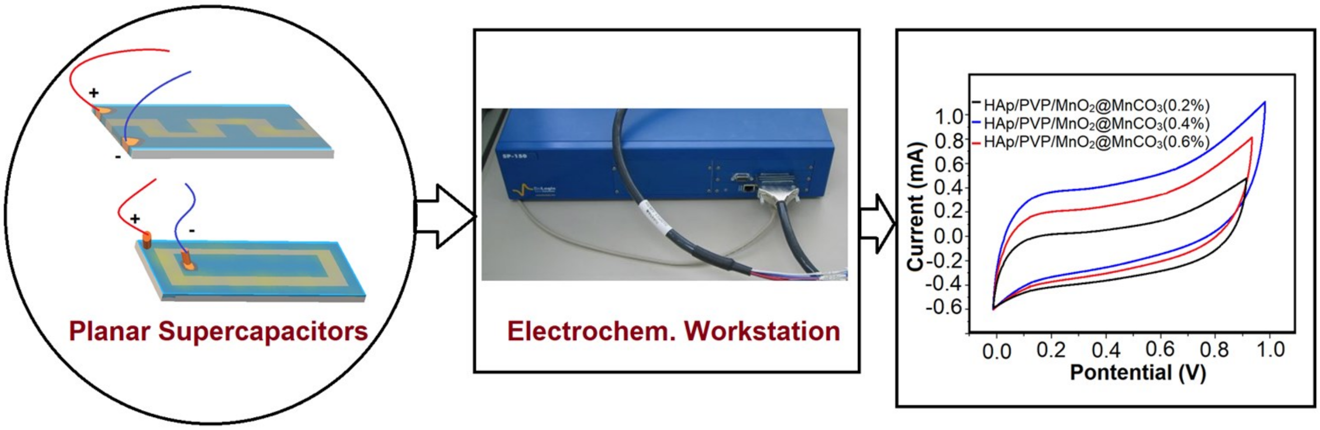
The FTIR spectrum of MnO_2@$MnCO_3$ shows typical peaks around 790, 860 and 1550cm^{-1}, which are dominant for carbonate ions (CO_3^{2-}). The peaks at 480 cm^{-1} and 651cm^{-1} attributed for Mn-O and this study evidenced for the formation of MnO_2@$MnCO_3$. The HAp/PVP/MnO_2@$MnCO_3$ composite spectrum presence of the characteristic peaks at 3560 cm^{-1} for vibration modes of hydroxyl groups. The PO_4^{3-} peaks are clearly existing at 510 and 560 cm^{-1}. Also, the C-N peaks indicates the PVP incorporation in the composites. The remark of these peaks indicates that the CO_3^{2-}, Mn-O, C-N and PO_4^{3-} groups in the HAp/PVP/ MnO_2@$MnCO_3$, thus confirming the survival MnO_2 and $MnCO^3$ in the prepared composites.[1-3]

ESI Tab. 1 Pore diameter calculations from SEM results

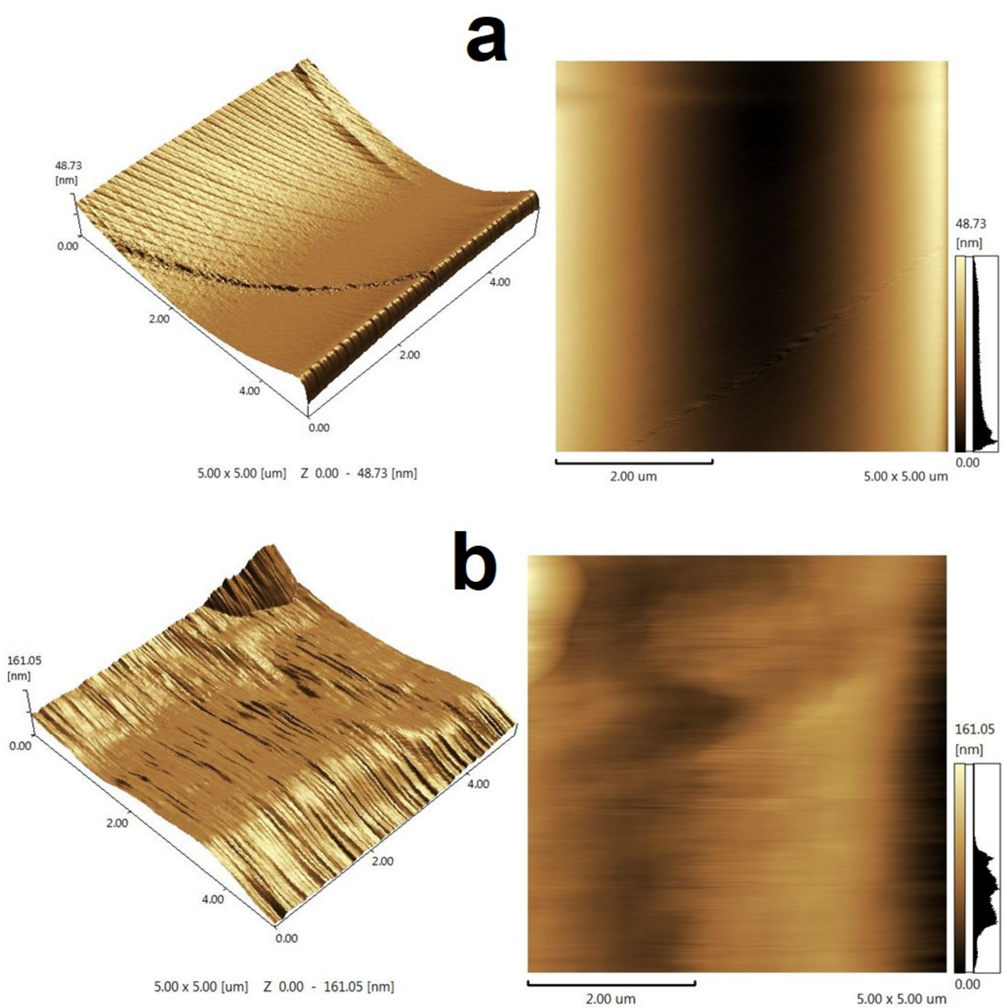
Label	Pore diameter (nm)	Mean	Min	Max	Angle
1	29	17.831	3	90	-15.524
2	16	18.703	1.113	63.5	-93.945
3	25	31.624	6.917	76.75	-40.732
4	20	35.033	13.473	50.302	13.671
5	5	79.088	54.625	105.5	-69.444
6	6	97.8	87.4	112	-29.055
7	13	67.172	3.75	130	-25.463
8	9	9.215	1.438	30.5	-31.608
10	7	106.595	85.333	123.083	4.764
11	9	12.205	0	62.5	0
Mean Pore diameter	13.9	47.527	25.705	84.414	-28.734
SD	8.373	36.871	35.828	33.094	33.322
Min	5	9.215	0	30.5	-93.945
Max	29	106.595	87.4	130	13.671



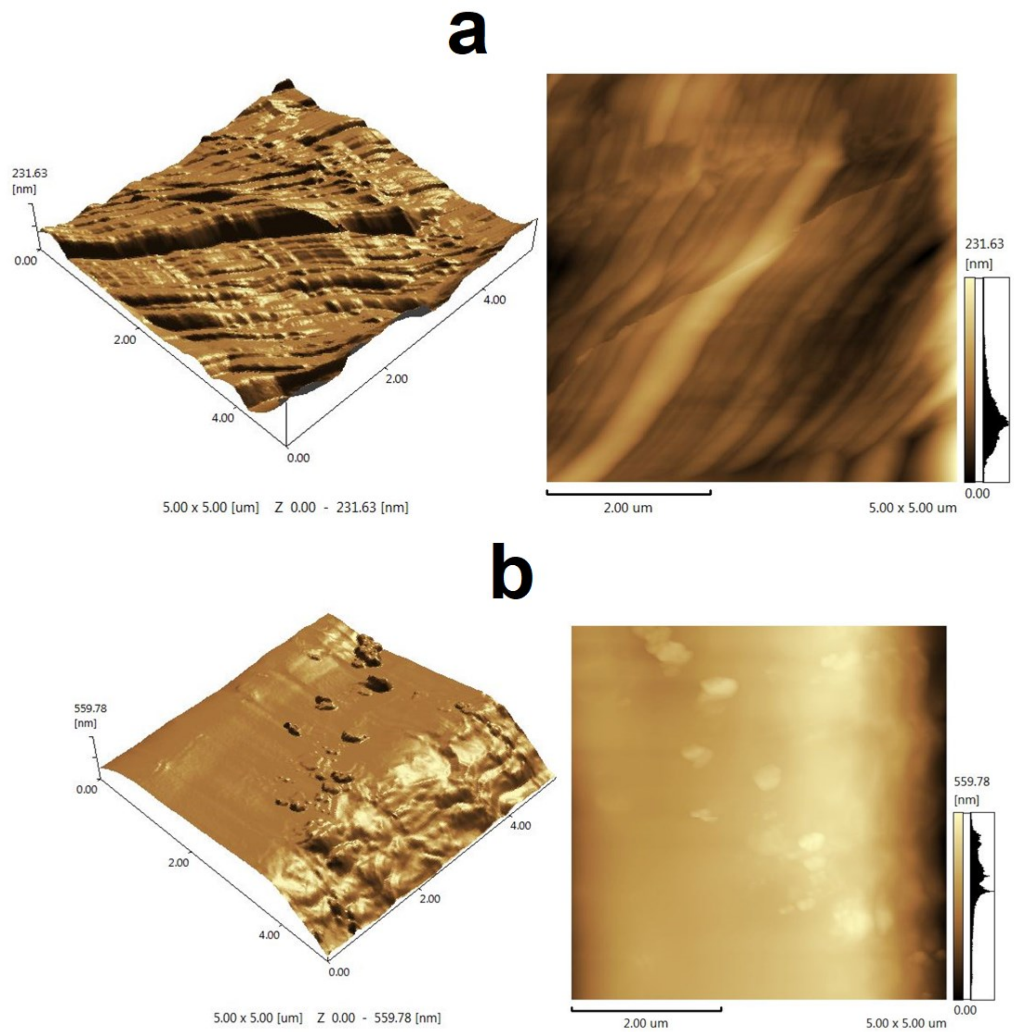
ESI Fig. 3. EDX analysis of MnO_2@$MnCO_3$ (a) and HAp/PVP/ MnO_2@$MnCO_3$ (b) composite.



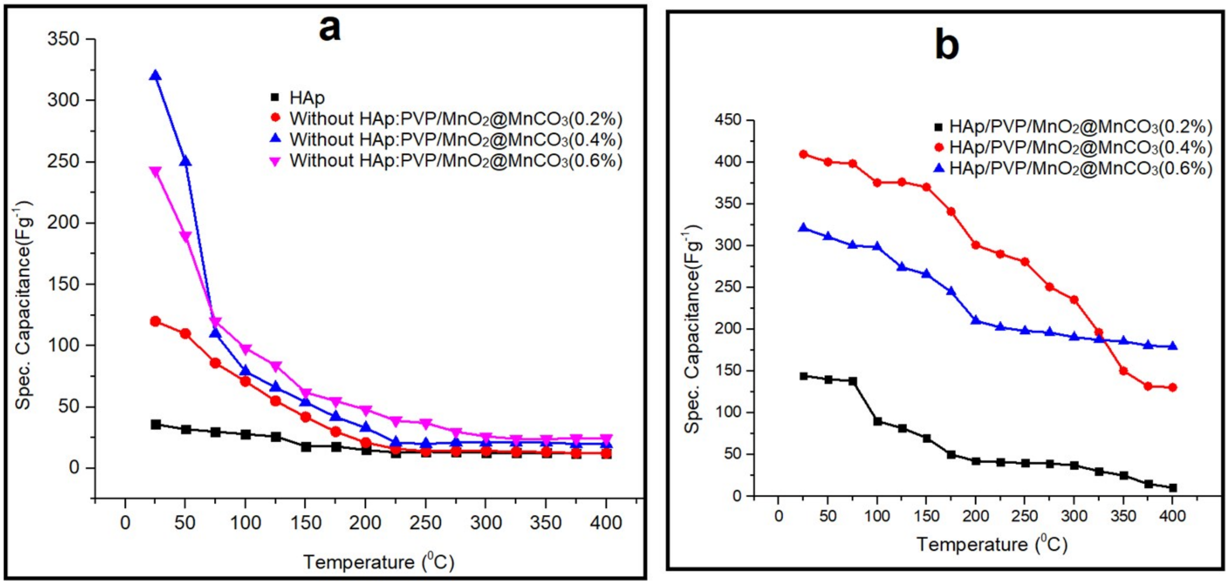
ESI Fig. 4. Electrochemical setup of planar supercapacitors



ESI Fig.5 AFM images of a. Carbon fabric (18.7nm) and b. HAp/PVP/MnO_2@$MnCO_3$ (0.2%) composite coated fabric (161.05nm)



ESI Fig.6 AFM images of a. HAp/PVP/MnO_2@$MnCO_3$ (0.4%) (231.63nm) and b. HAp/PVP/MnO_2@$MnCO_3$ (0.6%) composite coated fabric (559.78nm)



ESI Fig. 7. High temperature functioning performance of planner supercapacitors with HAp and without HAp.

Calculations

The Gravimetric specific capacitance was calculated from the galvanostatic discharge curves, using the following equation 1.

$$C = \frac{I\Delta t}{m\Delta V} ......1$$

Also, the aerial capacitance was calculated from equation 2

$$^{C}C = \frac{I\Delta t}{A\Delta V} ....2$$

Where (I) is charge or discharge current, Δ*t* (s) is the time for a full charge or discharge, *m* (g) designates the mass of the active material, A is the area of the active materials and Δ*V* signifies the voltage change after a full charge or discharge.

The energy density (E) considered by equation 3 .

$$E = \frac{C(\Delta V)^2}{2} Whkg^{-1} ......3$$

Where C is the specific capacitance of the active materials, and ΔV is the potential window of discharge.[4]

ESI Tab.2 Specific capacitance and Energy density profile of planner supercapacitors with HAp and without HAp.

Supercapacitor samples	Specific Capacitance (Fg^{-1})	Energy Density ($Whkg^{-1}$)
HAp	36.2	5.1
Without HAP(MnO_2@$MnCO_3$)0.2%	120.4	16.7
Without HAP(MnO_2@$MnCO_3$)0.4%	320.1	44.5
Without HAP(MnO_2@$MnCO_3$)0.6%	243.3	33.8
HAP/PVP/ MnO_2@$MnCO_3$ (0.2%)	144.5	20.1
HAP/PVP/ MnO_2@$MnCO_3$ (0.4%)	409.5	56.9
HAP/PVP/ MnO_2@$MnCO_3$ (0.6%)	325.1	45.2

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