Supplementary Information

Synergistic effects of liquid phase exfoliated molybdenum based 2D nanosheets and MWCNT for high performance supercapacitors

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Keywords: liquid phase exfoliation, Specific capacitance, Electrochemistry, Energy density, nanocomposite

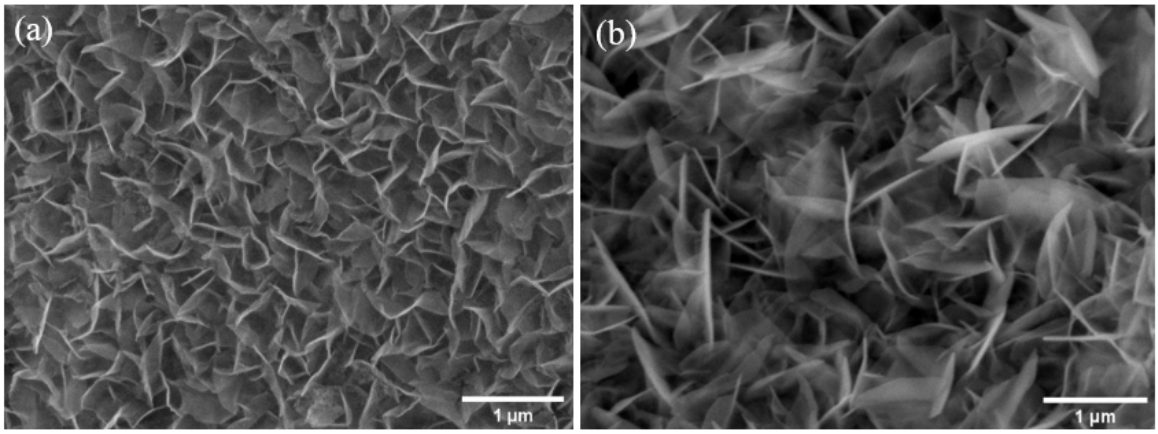

Figure S1 (a) FESEM image of exfoliated MoS_2 nanosheets at a scale of 500nm (b) FESEM image of exfoliated $MoSe_2$ nanosheets at a scale of 500nm.

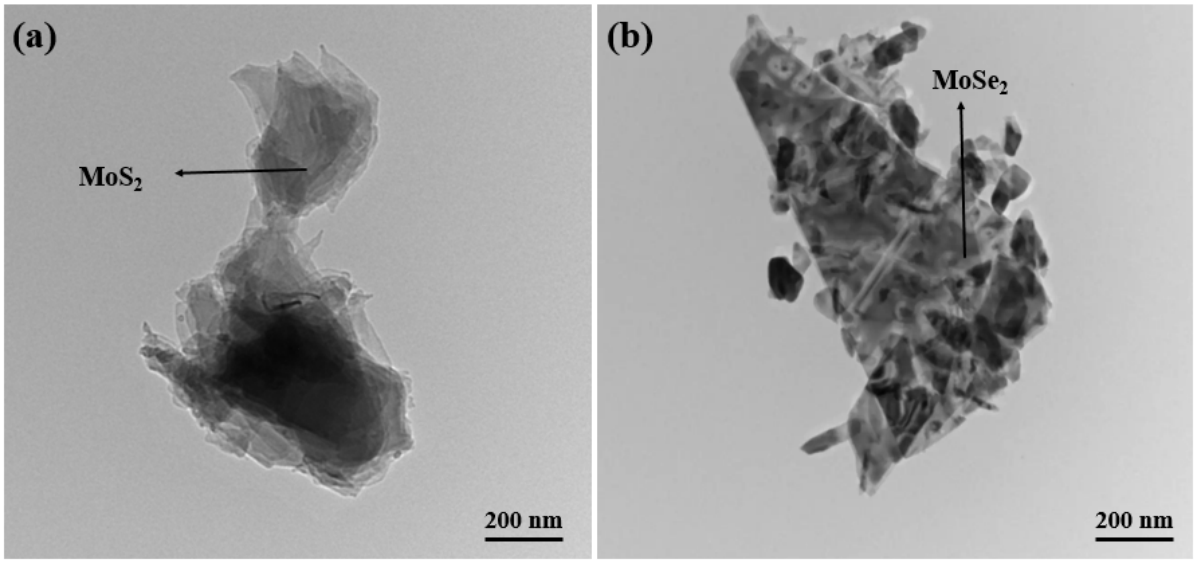

Figure S2 TEM images of (a) Exfoliated MoS_2 nanosheets and (b) Exfoliated $MoSe_2$ nanosheets.

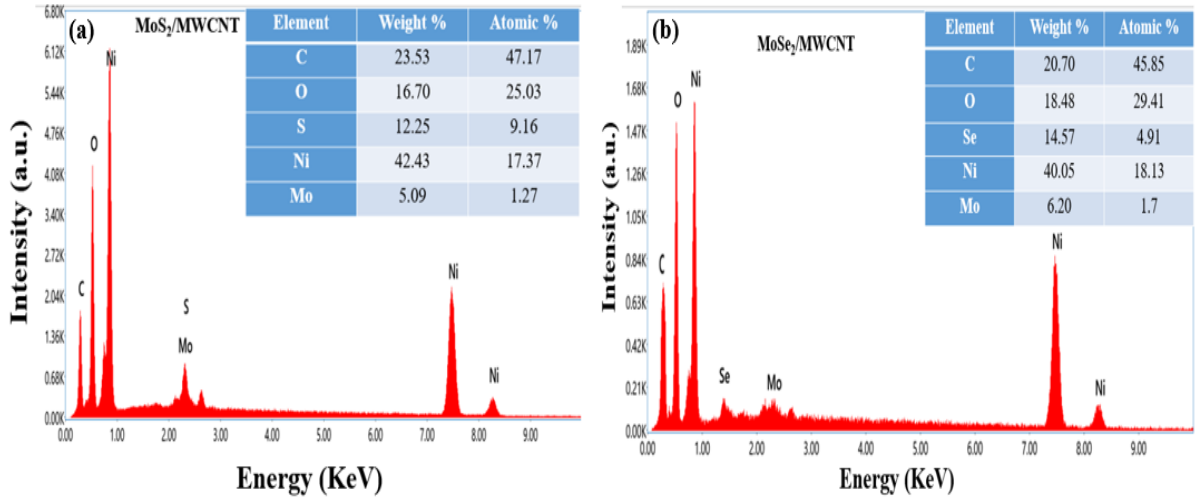

Figure S3 EDX spectra of (a) MoS_2/MWCNT and (b) $MoSe_2$/MWCNT nanocomposites.

In the EDAX of the MoS_2/MWCNT and $MoSe_2$/MWCNT nanocomposite, the presence of carbon (C) is expected due to the incorporation of multi-walled carbon nanotubes (MWCNTs) in the composite material. However, an unusually high weight percentage of carbon detected during EDAX can often be attributed to the use of carbon tape, which is commonly employed to mount the sample onto the EDAX stub and due to Ni foam substrate[1].

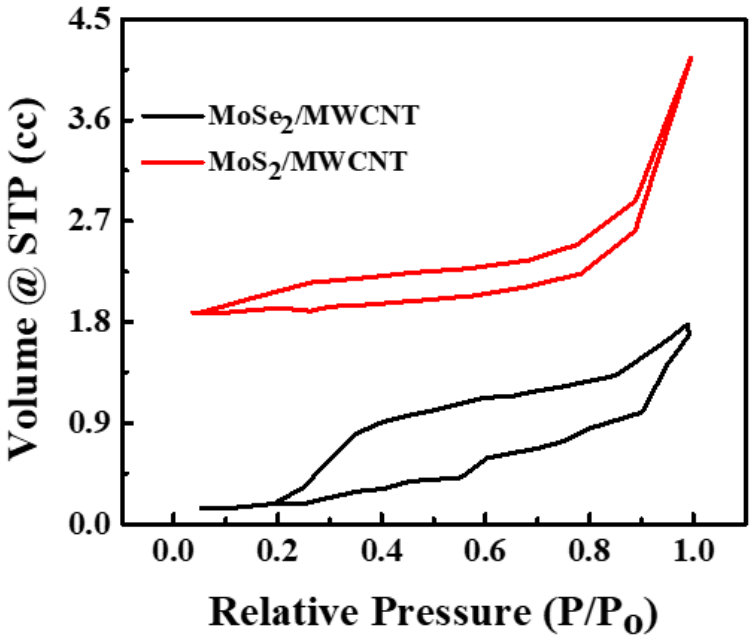

Figure S4 BET Isotherm of MoS_2/MWCNT and $MoSe_2$/MWCNT nanocomposites.

The BET isotherm of nanocomposites is shown in Supplementary Figure S4. The BET data of MoS_2, $MoSe_2$, MoS_2/MWCNT, $MoSe_2$/MWCNT, and MWCNT are shown in Table S1.MWCNTs have a high surface area due to their unique tubular structure [2]. The surface area of the $MoSe_2$/MWCNT and MoS_2/MWCNT are larger than the bare MoS_2 and $MoSe_2$. Also, there is an increase in the porosity of nanocomposite after adding MWCNT to MoS_2 and

$MoSe_2$. The MoS_2/MWCNT shows the largest surface area and pore volume which contributes to largest specific capacitance than all the other three electrodes.

Material	Surface Area (m^2/g)	Pore Volume (cc/g)
MoS_2	53.473	$1.095*10^{-1}$
MoS_2/MWCNT	97.671	$3.187*10^{-1}$
$MoSe_2$	60.743	$5.502*10^{-2}$
$MoSe_2$/MWCNT	92.251	$1.004*10^{-1}$
MWCNT	157	0.176

Table S1: BET data for MoS_2, $MoSe_2$, MoS_2/MWCNT, $MoSe_2$/MWCNT and MWCNT.

Electrochemical Characterizations of MWCNT electrode

The CV curves of the MWCNT electrode are shown in Figure S5 (a) from a scan rate of 5 mV/s to 100mV/s in the potential range between 0 and 0.6 V. The maximum specific capacitance of MWCNT is calculated from CV curves is 549.96 F/g at the scan rate of 5mV/s. The specific capacitance at 100 mV/s is 85.30 F/g. Figure S5 (b) shows the GCD curves of MWCNT electrode from the current density of 3A/g to 25A/g. The maximum specific capacitance calculated from GCD curves at 3A/g is 570 F/g while the specific capacitance at 25A/g is 100 F/g. From the GCD curves, the maximum energy density calculated for MWCNT is 19.79 Wh/Kg at power density of 750 W/Kg. Figure S5 (c) shows the EIS curve for MWCNT electrode having series resistance of 4.95Ω. Figure S5 (d) shows the cyclic stability of MWCNT electrode which has 91% capacity retention after 4000 cycles.

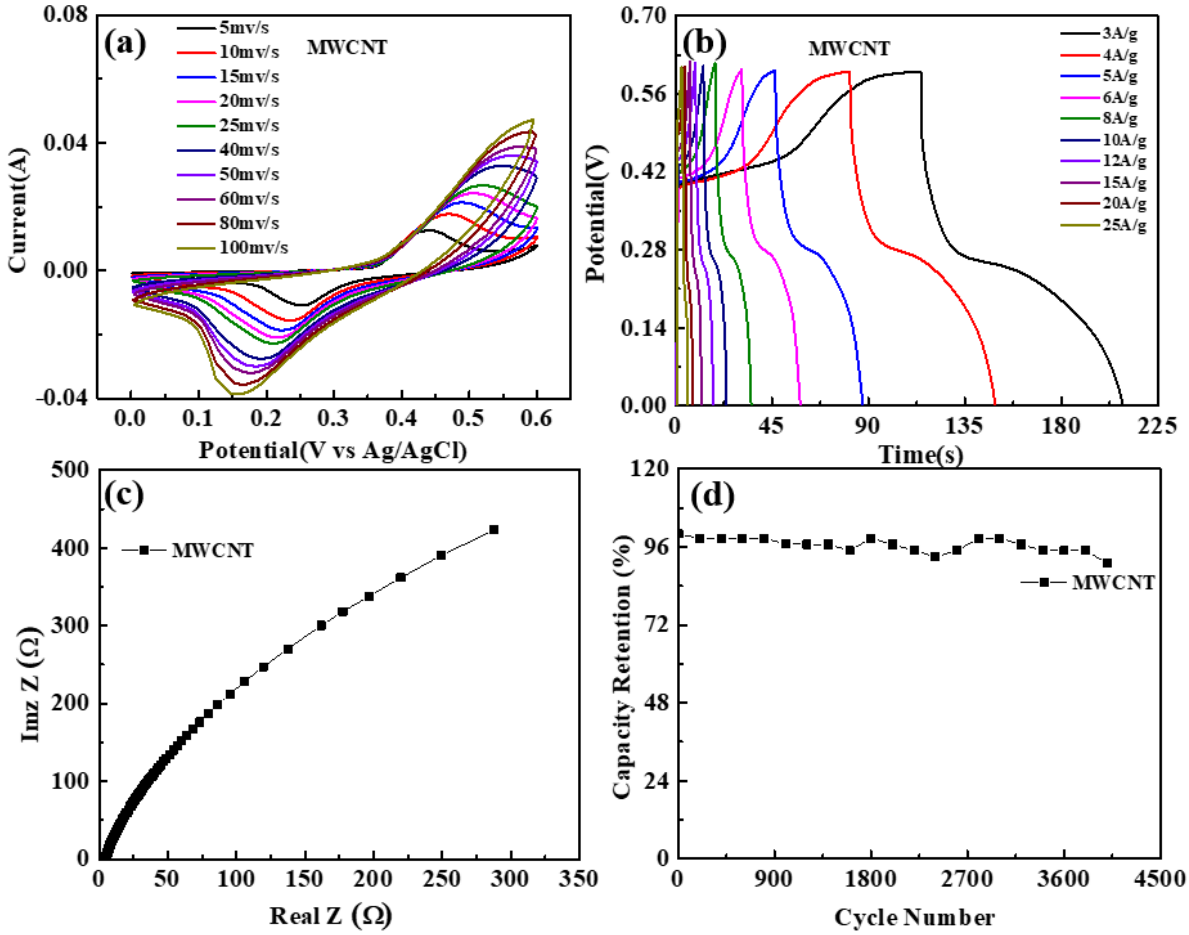

Figure S5: (a) CV curves (b) GCD curves (c) EIS curve (d) Capacity Retention curve of MWCNT electrode.

References

[1] Mikolajczyk, T.; Pierozynski, B.; Smoczynski, L.; Wiczkowski, W. Electrodegradation of Resorcinol on Pure and Catalyst-Modified Ni Foam Anodes, Studied under Alkaline and Neutral pH Conditions. *Molecules* **2018**, *23* (6), 1293.

[2] Yadav, M. D.; Patwardhan, A. W.; Joshi, J. B.; Dasgupta, K. Kinetic Study of Multi-Walled Carbon Nanotube Synthesis by Thermocatalytic Decomposition of Methane Using Floating Catalyst Chemical Vapour Deposition. *Chemical Engineering Journal* **2019**, *377*, 119895.