

## Electronic Supplementary Information

### **Microwave Assisted Fast Formation of Sn(MoO<sub>4</sub>)<sub>2</sub> Nano-assemblies on DNA Scaffold for Application in Lithium-ion Batteries**

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#### **Instruments.**

Aggregated, self-assembled and chain-like Sn(MoO<sub>4</sub>) nanomaterials on DNA scaffold were characterized using several spectroscopic techniques. The transmission electron microscopy (TEM) analysis was done with a Tecnai model TEM instrument (Tecnai™ G2 F20, FEI) with an accelerating voltage of 200 KV. The Field Emission Scanning Electron Microscopy (FE-SEM) analysis was recorded with Zeiss ultra FE-SEM instruments. The Energy Dispersive X-ray Spectroscopy (EDS) analysis was done with the same FE-SEM instrument with a separate EDS detector (INCA) connected to that instrument. The UV-Visible (UV-Vis) absorption spectra were recorded in a double beam spectrophotometer purchased from Unico (model 4802 UV-Vis spectrophotometer). The X-ray diffraction (XRD) analysis was done using a PAN analytical Advanced Bragg-Brentano X-ray powder diffractometer (XRD) with Cu K $\alpha$  radiation ( $\lambda = 0.154$  nm) with a scanning rate of 0.020 s<sup>-1</sup> in the 2 $\theta$  range 10-90°. The X-ray photoelectron spectroscopic (XPS) analysis was done to check the chemical composition and the oxidation state of elements present in the outermost part of materials and analyzed by using Theta Probe AR-XPS System, Thermo Fisher Scientific (U.K). The LASER

Raman measurements were carried out with Renishaw inVia Raman Microscope using an excitation wavelength of 633 nm (He-Ne laser). The excitation light intensity in front of the objective was ~10 mW with a spectral collection time of 1 sec for Raman experiment. The integration time for our measurement was set to 10 sec. Thermal analysis was made with a thermal analyser-simultaneous TGA/DTA instrument with model name SDT Q600 and the analysis was performed in air. The Fourier Transform Infrared (FT-IR) spectroscopy analysis was done with the model Nexus 670 (FT-IR), Centaurms 10X (Microscope) having spectral range 4,000 to 400  $\text{cm}^{-1}$  with a MCT-B detector. A hot air oven (temperature up to 1000 °C) was used to anneal the samples at specific temperature. A domestic microwave (MW) oven (Samsung Company, DE68-03714B) was used for the MW heating during the entire synthesis. The output power was 1000 W and the operating frequency was 2450 MHz. Electrochemical studies related to LIB applications were carried out using VMP3 (Bio-Logic) electrochemical work station and ARBIN charge-discharge cycle life tester.

#### **Preparation of samples for other spectroscopic and instrumental characterizations.**

The aggregated  $\text{Sn}(\text{MoO}_4)_2$  nano-assemblies as chain-like morphology on DNA scaffold were characterized using UV-Vis, TEM, FE-SEM, EDS, XRD, XPS, Raman, thermal analysis, and FT-IR studies. For UV-Vis study a liquid solution was made by sonicating the solid  $\text{Sn}(\text{MoO}_4)_2$  powder for 20 min with DI water. The samples for TEM was prepared by placing a drop of the diluted  $\text{Sn}(\text{MoO}_4)_2$  NPs solution onto a carbon coated Cu grid followed by slow evaporation of solvent at ambient conditions. For EDS, XRD, XPS, Laser Raman, and FT-IR analyses, the prepared powder samples (annealed at 600 °C in air) were directly used for the measurements. For FE-SEM analysis, the samples were prepared in a similar way as discussed before on glass slides but with a single deposition. For TGA/DTA analysis, the synthesized  $\text{Sn}(\text{MoO}_4)_2$  nanopowders are used for the measurement. Fabrication of electrodes for LIB study has been described in the main text.

#### **Energy Dispersive X-ray Spectroscopy (EDS) analysis.**

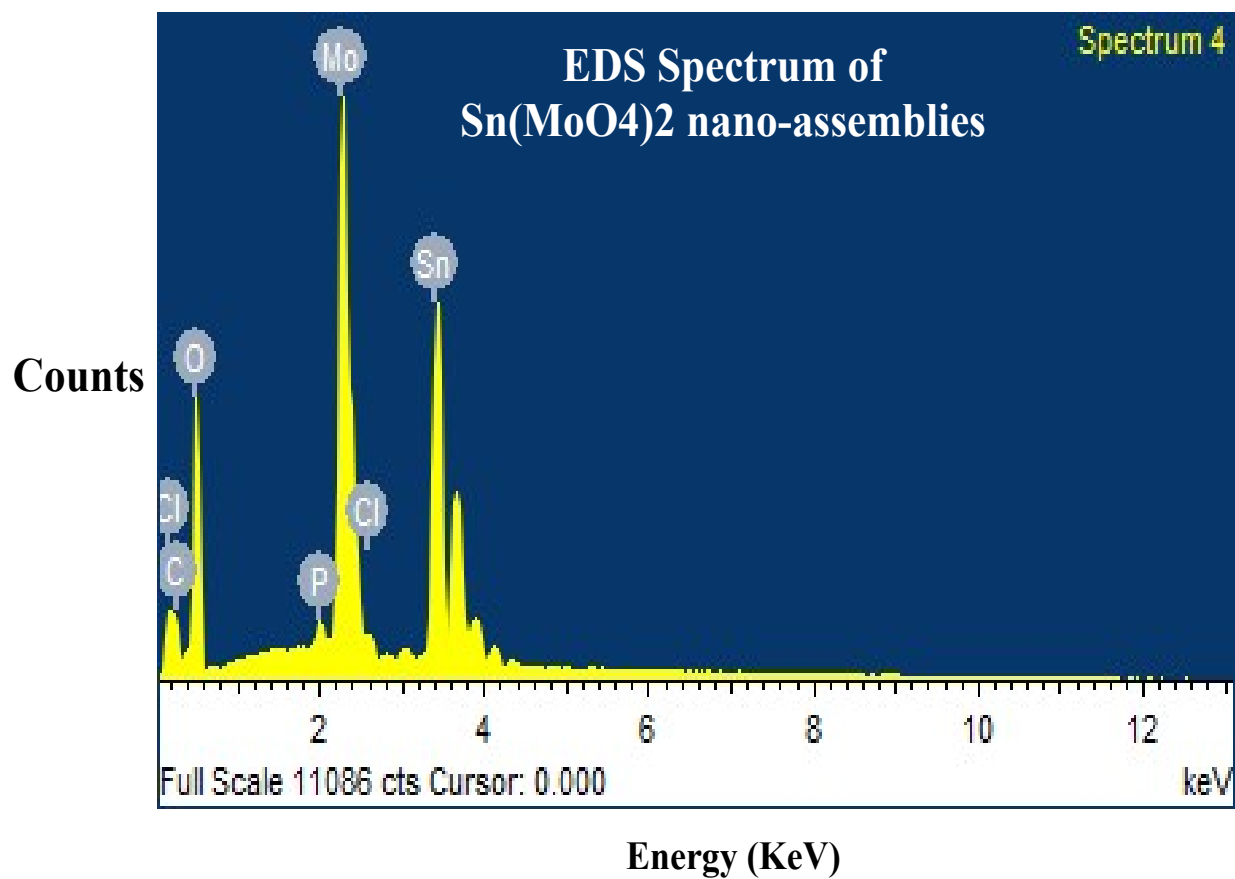
Figure S-1 shows the energy dispersive X-ray spectroscopy (EDS) analysis of the chain-like  $\text{Sn}(\text{MoO}_4)_2$  nano-assemblies, which is used to identify the specific elements present in the synthesized product. The EDS spectrum consists of different peaks for C, O, Cl, P, Sn and Mo. Herein, Cl peak is due to the chloride salt used during synthesis and the C and P peaks originate from DNA used during the synthesis. The high intense Sn, Mo and O peaks are due to the  $\text{Sn}(\text{MoO}_4)_2$  nanomaterials. Presence of P peak with the expected Sn, Mo and O peaks

confirm the binding of  $\text{Sn}(\text{MoO}_4)_2$  with DNA. The peaks observed in EDAX spectrum beyond the range of 3.44 eV are belonging to the L family of Sn. The peak at 3.44 eV is characteristic peak of Sn corresponds to the L-alpha of L family. Along with L-alpha, there are four noticeable peaks observed in the range of 3.44 to 4.4 eV. They are named as L-beta 1, beta 2, gamma 1, and gamma 3 and are in the ratios of 70: 20: 8: 3 with respect to L-alpha. The atomic ratio Sn, Mo and O is found to be 13.10:27.62:57.28 respectively, which is closer to the stoichiometric ratio of  $\text{Sn}(\text{MoO}_4)_2$ .

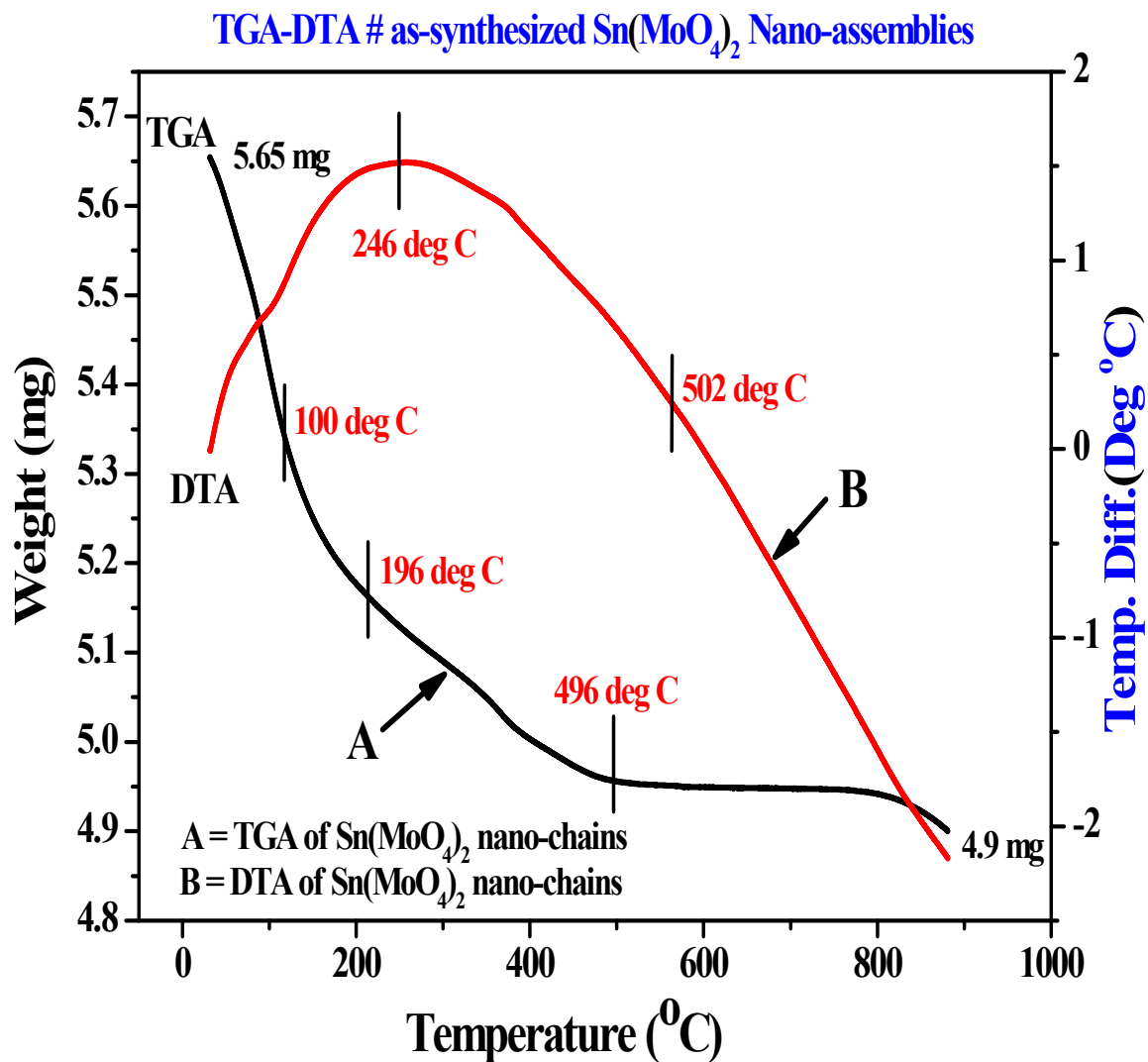
### **Thermal analysis study.**

Thermogravimetric analysis(TGA) and differential thermal analysis (DTA) of the as-synthesised samples are shown in Figure S-3, where curve A shows the TGA and curve B shows the DTA curves of  $\text{Sn}(\text{MoO}_4)_2$  nano-assemblies on DNA scaffold. The as-synthesized sample was heated up to 900 °C from room temperature at a heating rate of 10 °C/min in air. From the TGA curve, we can see that there is a steep weight lost slope from 100 to 196 °C and then the curve is exhibiting a flat behaviour. Another steep weight loss starts and continues up to 500 °C. The first weight loss is probably due to the loss of water molecules or moisture adsorbed on the sample and the second weight loss is probably due to the loss of other chemicals or free DNA molecules in the sample. Within a range of 500 to 800 °C, there is no noticeable weight loss observed but around 800 -900 °C, a small weight loss is observed that might be due to the burning of DNA residues or change in the sample morphology. From the DTA curve, we can see that there is a sharp exothermic peak which appears at 246 °C, corresponding to the initial decomposition of the precursor material and the other exotherm near 500 °C is due to the phase change of  $\text{Sn}(\text{MoO}_4)_2$  nano-assemblies from amorphous to crystalline phase. With regard to TGA curve, we have started the analysis with 5.65 mg of sample and after heating up to 900 °C, the remaining sample weighs about 4.9 mg. So the percentage of weight loss due to the thermal treatment up to 900 °C is 13.27 %. A similar type of TGA-DTA spectrum has been reported by Xiao et al. for their Ni or Co molybdates.<sup>14</sup> A small % of weight loss with a broad temperature range indicates the high stability of our synthesized  $\text{Sn}(\text{MoO}_4)_2$  nano-assemblies.

Reference 14 as shows above text is given in main text.



**Figure S-1:** Energy dispersive X- ray spectroscopy (EDS) analysis of the chain-like  $\text{Sn}(\text{MoO}_4)_2$  nanomaterials consisting of different peaks for C, O, Cl, P, Sn and Mo.



**Figure S-2:** Thermogravimetric analysis (TGA, curve A) and differential thermal analysis (DTA, curve B) of the as-synthesised Sn(MoO<sub>4</sub>)<sub>2</sub> nano-assemblies samples. The as-synthesized sample was heated up to 900 °C from room temperature at a heating rate of 10 °C/min in air.

<b>FT-IR bands - de-oxyribo nucleic acid (DNA)-Experimental and Reported values</b>		
<b>FT-IR bands (cm<sup>-1</sup>) (experimentally observed)</b>	<b>FT-IR frequency range (cm<sup>-1</sup>) (reported value)<sup>51</sup></b>	<b>Absorbing bonds/vibration types</b>
3211, 3428	3100-3750	v (OH group in DNA/water)
2882	2800-2950	Symmetric stretching vibration (C-H bonds in – CH <sub>2</sub> group)
1635	1732-1595	C=O, C-N, N-H <sup>51</sup>
1488	1492-1480	Bending ( $\delta$ ) of C-H bond in CH <sub>2</sub> <sup>51</sup>
1230	1170-1300	Asymmetric stretching of PO <sub>2</sub> <sup>-</sup> group
958, 1073	1140-950	v (C-O-C, C-C) <sup>51</sup>
462, 644, 768	800-1000	De-oxyribose region

Reference 51 is given in main text.

**Table S-1:** Specific FT-IR band values reported for DNA and experimentally observed band assignments.