Supporting Information

Enhanced Energy Storage Efficiency with $NbSnMoS_2$ Nanosheets as Electrode Material in Hybrid Supercapacitor Devices

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The FE-SEM surface morphologies with energy dispersive spectroscopy (EDS) technique provide valuable insights into the spatial arrangement of each element, contributing to a comprehensive understanding of the material's chemical composition. Figures S1, S2, and S3 illustrate the insights gained from the EDS technique regarding the compositional homogeneity of $NbMoS_2$, $SnMoS_2$, and $NbSnMoS_2$, respectively. The elements present in $NbMoS_2$ include Nb, Mo, and S; in $SnMoS_2$, the elements are Sn, Mo, and S; and in $NbSnMoS_2$, the elements are Nb, Sn, Mo, and S, as confirmed in Figures S1, S2, and S3. Additionally, EDS mapping validates the homogeneous distribution of all elements.

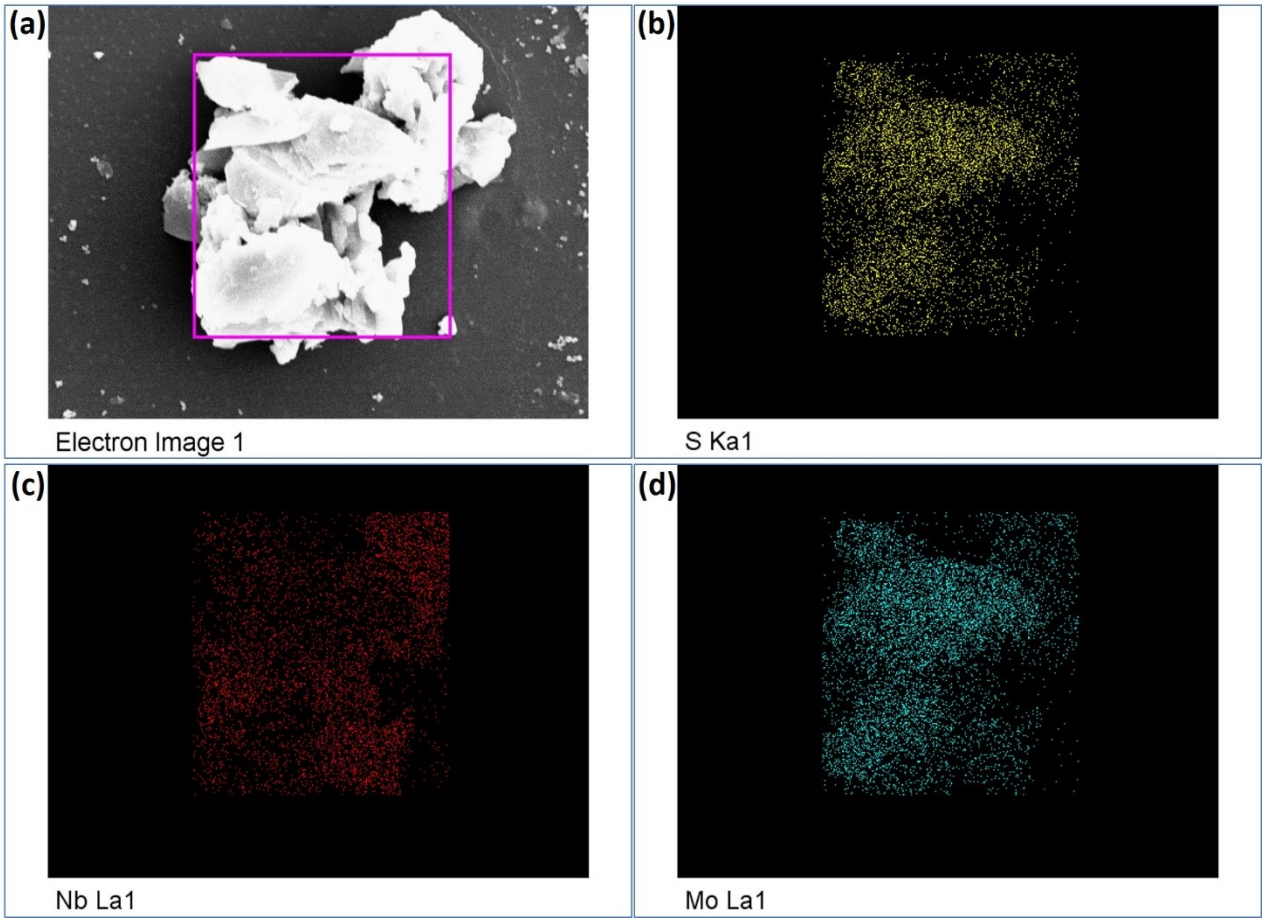

Figure S1. (a) FE-SEM surface images and (b-d) EDS elemental dot mapping images of the $NbMoS_2$.

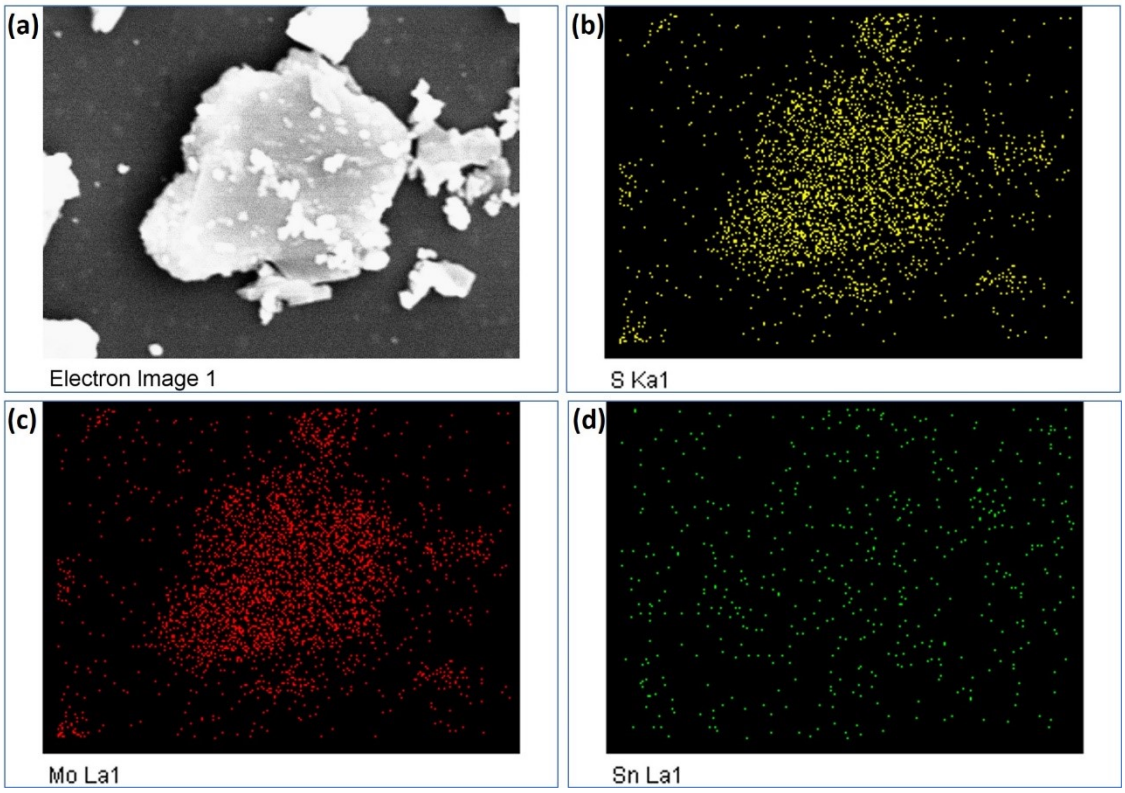

Figure S2. (a) FE-SEM surface images and (b-d) EDS elemental dot mapping images of the $SnMoS_2$.

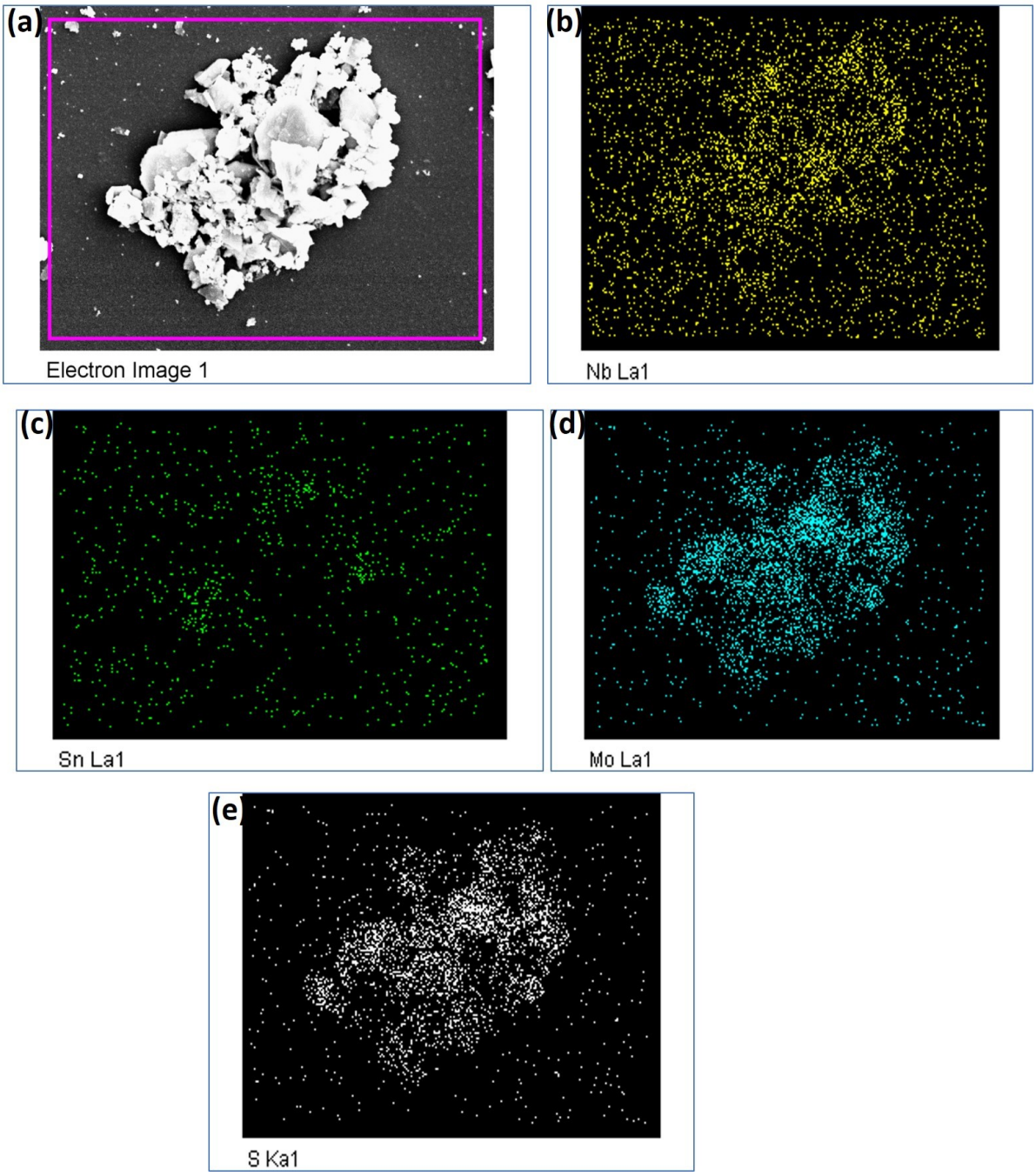

Figure S3. (a) FE-SEM surface images and (b-d) EDS elemental dot mapping images of the $NbSnMoS_2$.

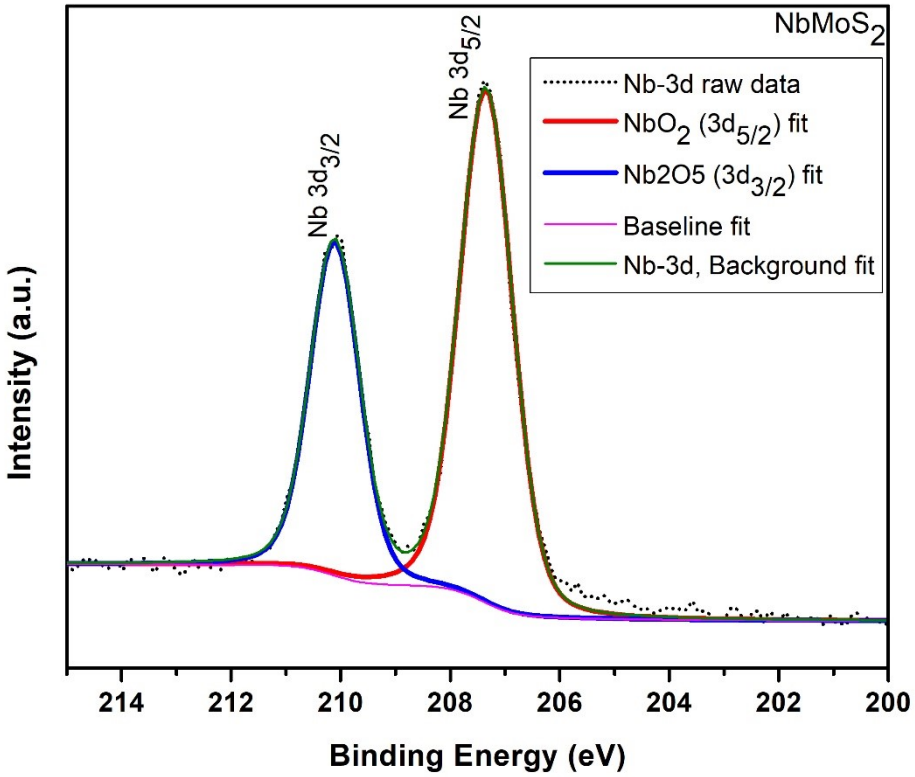

Figure S4. The XPS spectra of the niobium Nb3d peak for $NbMoS_2$ and deconvoluted the XPS peaks fitting of Nb3d core level $3d_{3/2}$, $3d_{5/2}$.

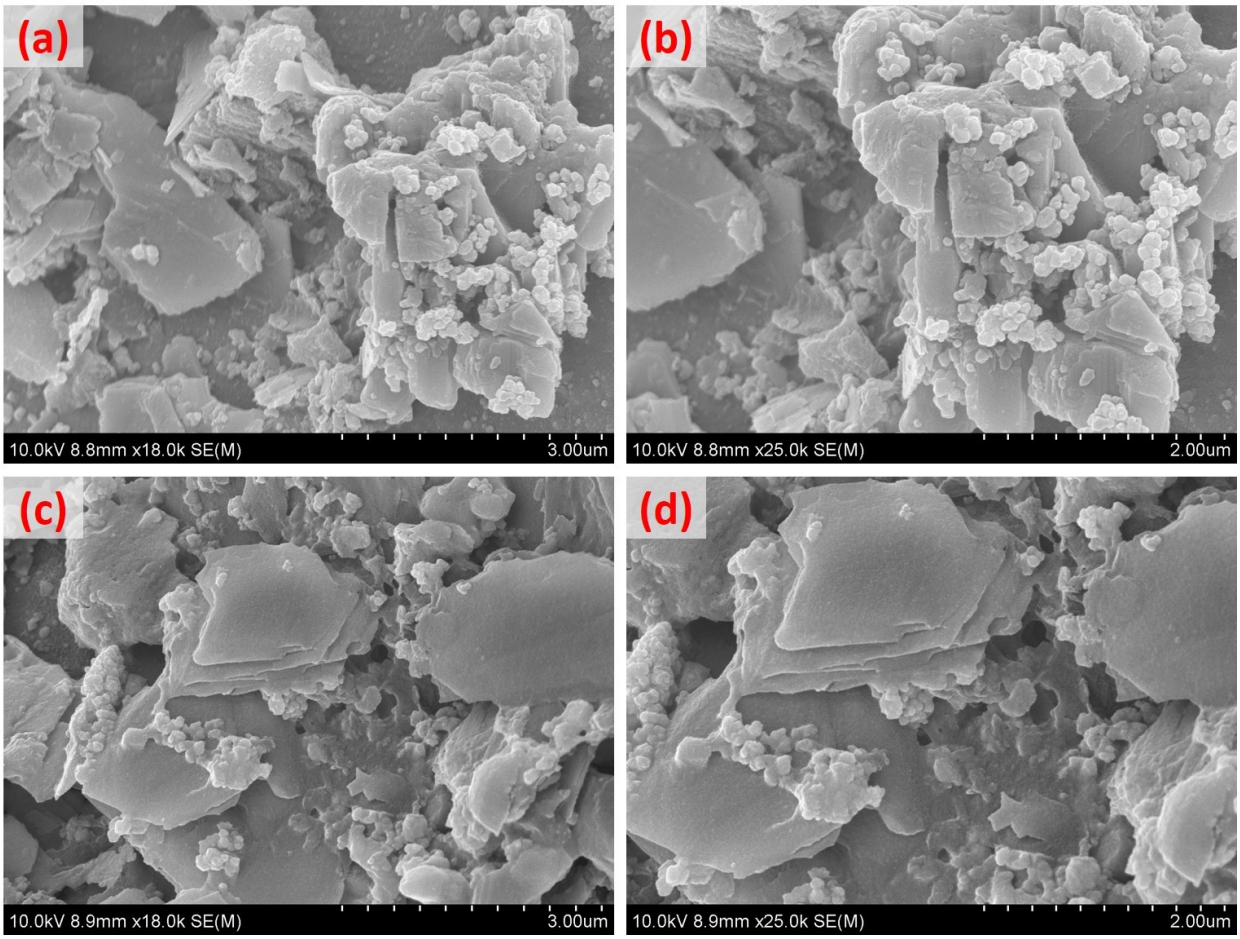

Figure S5. (a-d) FE-SEM surface morphologies images of $NbSnMoS_2$ electrodes, (a & b) morphology of the electrode surface before and (c & d) after cycling stability images.

Figure S5 (a-d) depicts the morphological changes in the $NbSnMoS_2$ electrode before and after cycling. As-prepared fresh electrodes with active materials (Figures S5(c,d) is evident that the MoS nanosheets and metal oxide spherical nanoparticles are distinctly connected with the binder particles and activated carbon used in electrode fabrication. Moreover, Figures S5(c,d) reveal the infiltration of KOH electrolyte into the sample, resulting in a clustered appearance in the FESEM studies after cycling surface morphologies. Furthermore, the FESEM images post-cycling exhibit the same morphology as the pre-cycling stage, affirming the enhanced stability of the prepared electrode active materials.

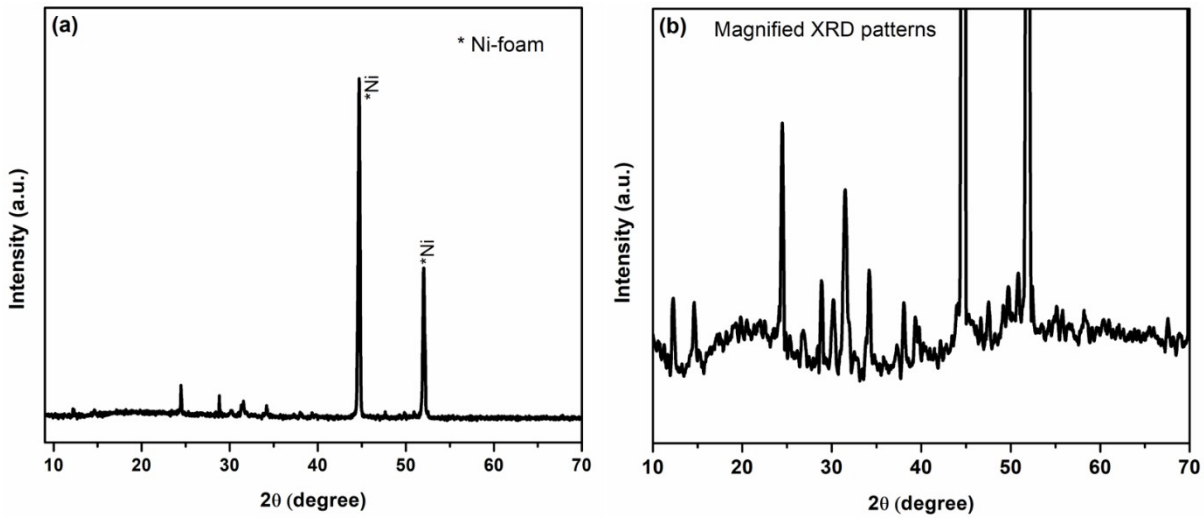

Figure S6. (a) XRD pattern of $NbSnMOS_2$ electrode and (b) magnified view XRD crystalline pattern

Figure S6 shows the after cycling XRD pattern of the $NbSnMoS_2$ electrode. The XRD pattern exhibits $NbSnMoS_2$ sample XRD peaks with high intense Ni peaks. Because the Ni foam was used as substrate. This results further confirms the stability of the $NbSnMoS_2$ electrode.