Electronic Supplementary Information

Prevention of sulfur diffusion using MoS_2-intercalated 3D-nanostructured graphite for high-performance lithium-ion batteries

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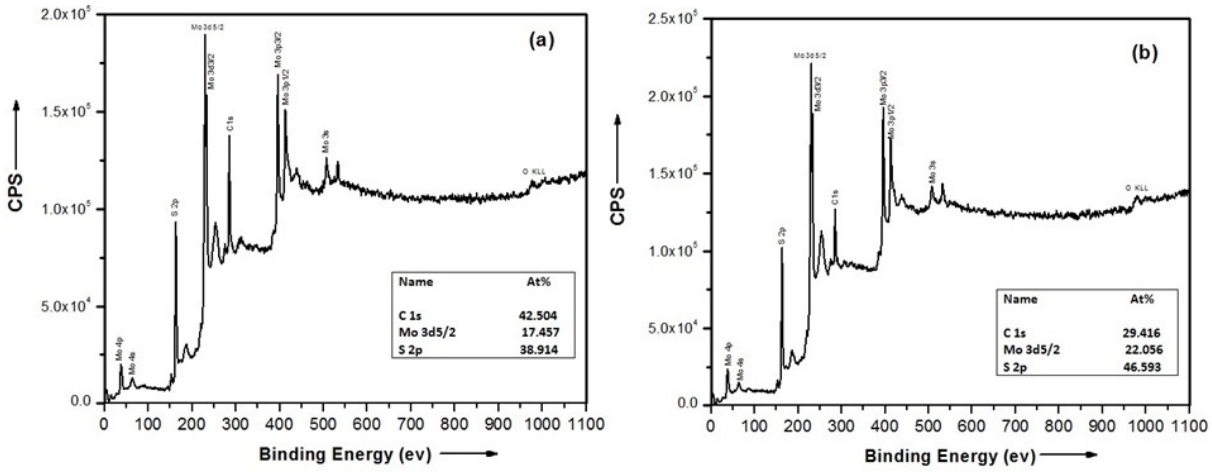


Figure S1. XPS analysis of (a) EGS-M1 and (b) EGS-M2 .

To determine the chemical composition of MoS_2 intercalated graphite 3D-nanostructured composites EGS-M1 and EGS-M2, X-ray photospectroscopy (XPS) measurements were carried out in the region of 0 ~1100 eV. Figures S1 (a) and (b) show that the sample contains the C, Mo and S elements and the atomic ratio of the elements is summarized in the insert of Figures S1 (a) and (b). The calculated atomic ratio of Mo to S element is 1 to 2.11 and 1 to 2.23 for EGS-M1 and EGS-M2 samples, approaching the theoretical value of MoS_2. The high-resolution of C1s can be seen apart from the "C = C" bond. In addition, we did not observe chlorine peaks in XPS measurement, which implies that 10 min microwave treatment is sufficient for the reaction between $MoCl_5$ and sulfur to form MoS_2 sheets.

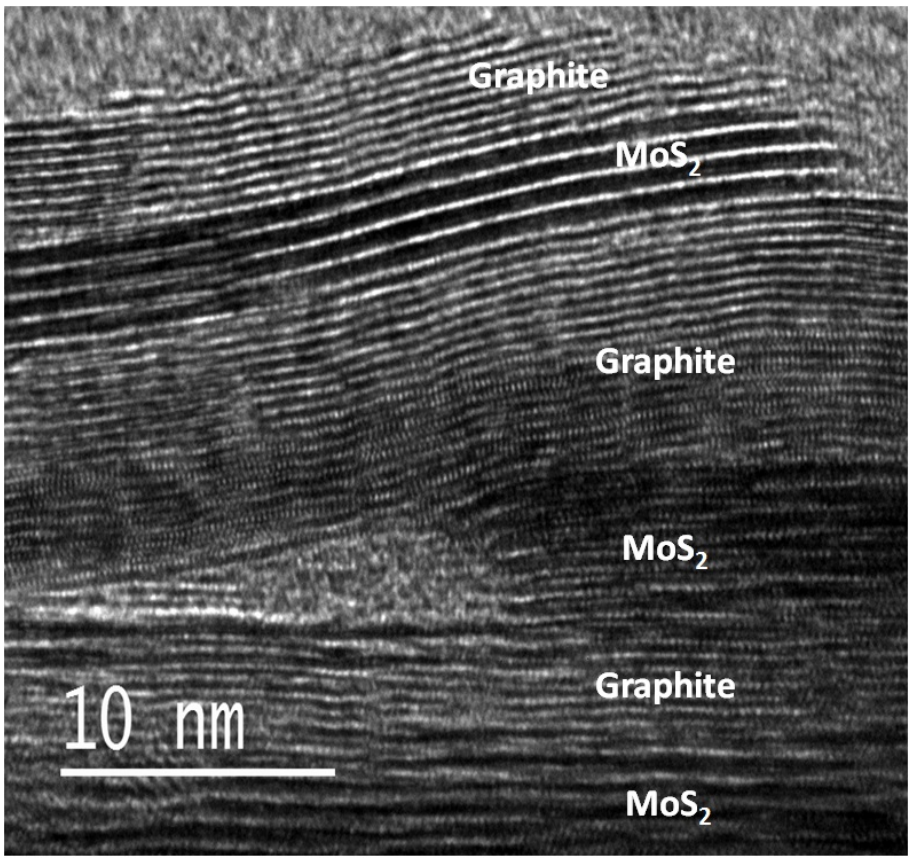
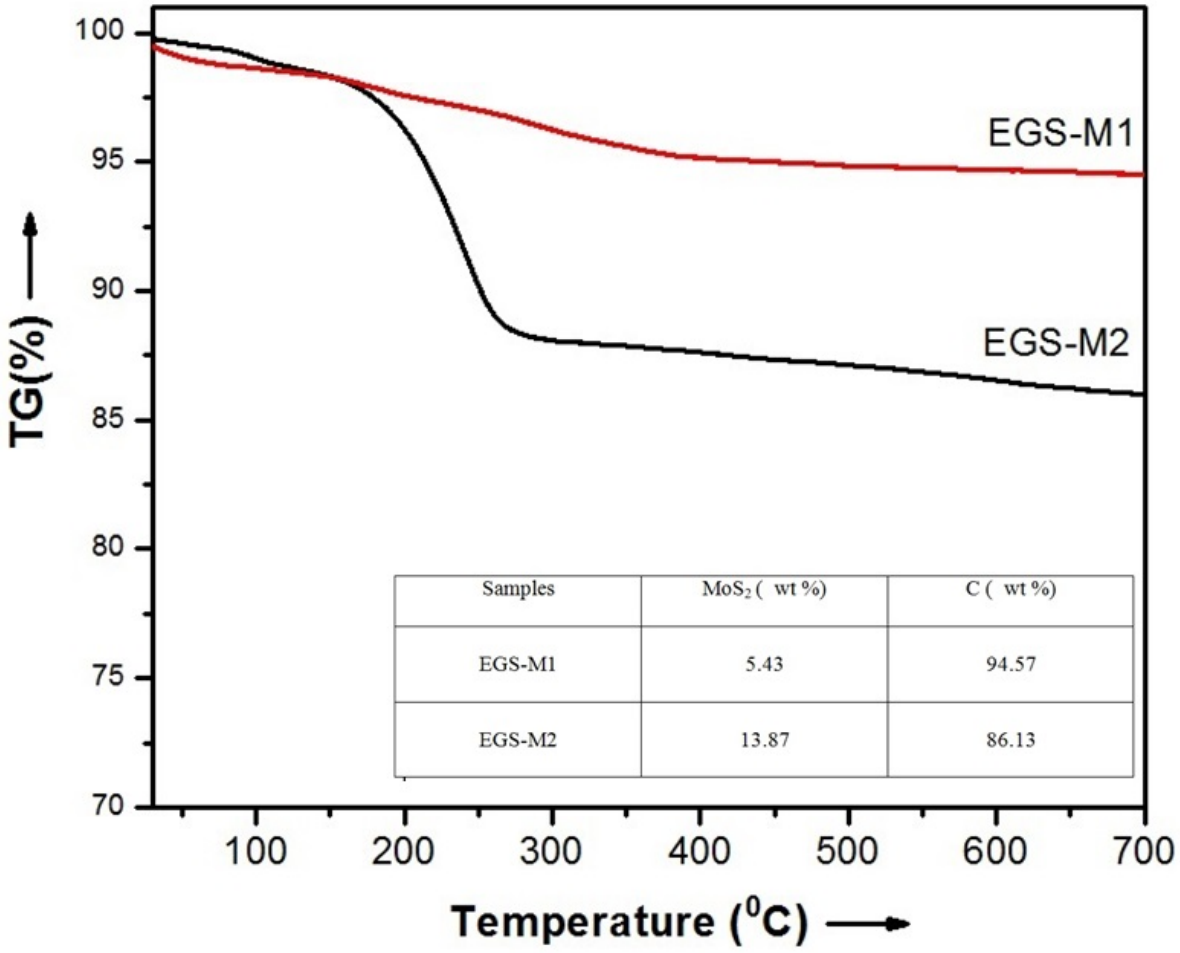


Figure S2. HRTEM image of EGS-M1 sample. It can be seen that the MoS_2 sheets are intercalated between the graphite layers and form the repeated 3D-nanostructure as graphite/MoS_2/graphite.



Samples	MoS_2 (wt %)	C (wt %)
EGS-M1	5.43	94.57
EGS-M2	13.87	86.13

Figure S3. TGA curve of EGS-M1 and EGS-M2 samples: The EGS-M1 and EGS-M2 samples exhibit two weight losses. The first weight loss appears between 230-250 ^{0}C, which can probably be illustrated to the removal of oxygen-containing groups. The second weight loss is continuous in the range of 300-450 ^{0}C. This thermal behavior might be caused by the decomposition of the amorphous carbon and graphite, and oxidation of MoS_2 in the composites. The mass fraction of MoS_2 in the EGS-M1 and EGS-M2 samples can be determined to be around 5.43 wt% and 13.87 wt%, respectively, assuming the complete conversion from MoS_2 to MoO_3.

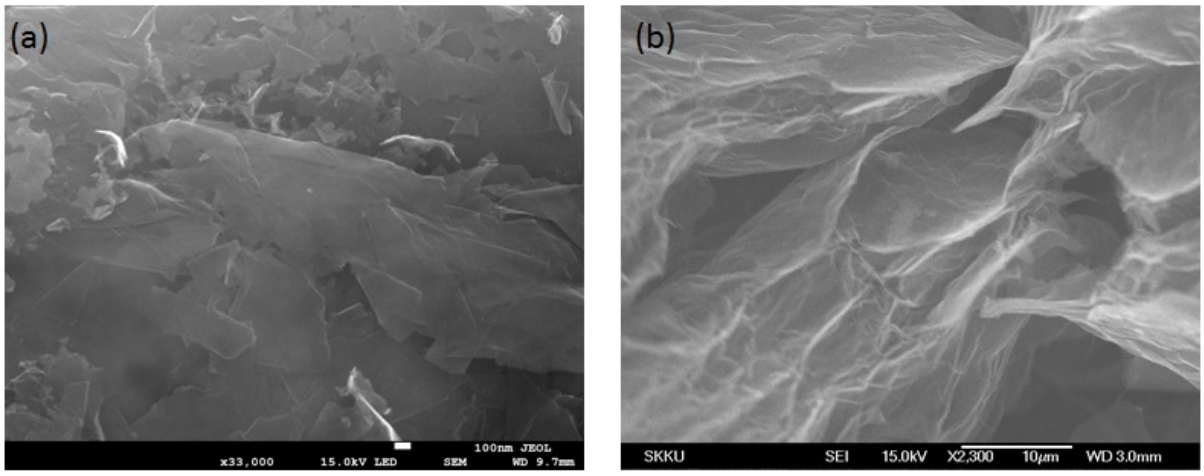


Figure S4 FESEM images of (a) sulfur intercalated edged open graphite and (b) edged open graphite.

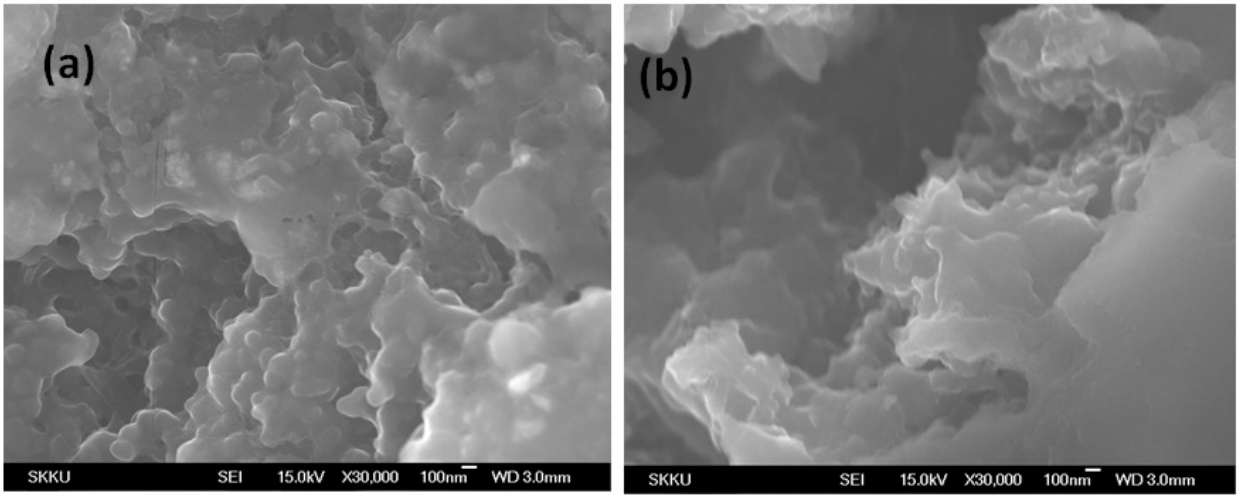


Figure S5. FESEM images of (a) EGS-M1 and (b) EGS-M2 composites after the 100 cycles of charging and discharging pcocess. It is illustrated from Figure S5(b) that during the cycling, there are aglomoration of the particles in EGS-M2 composite due to curling up of vertically grown MoS_2. However, the structure of EGS-M1 is not changed.

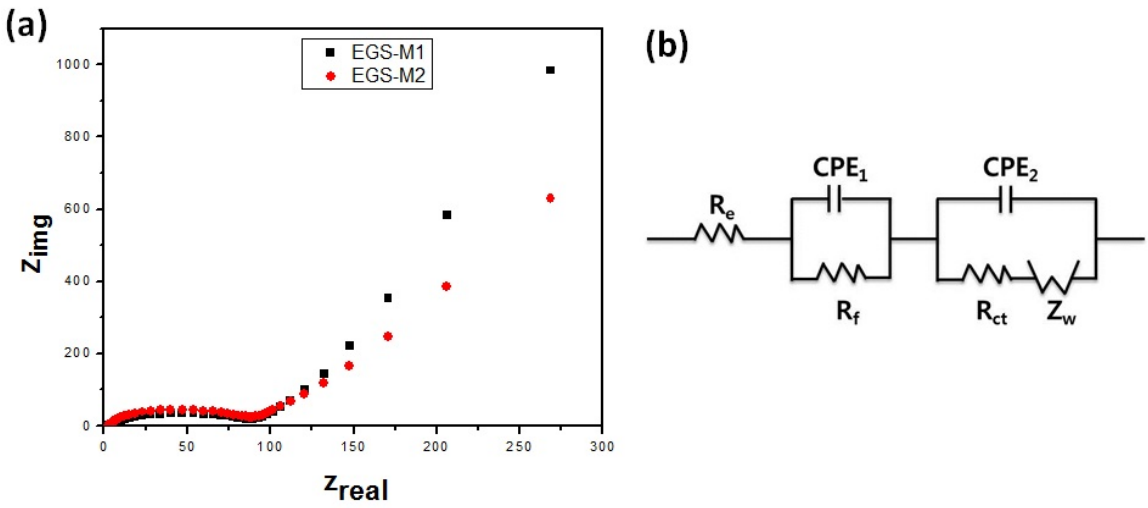


Figure S6 (a) Nyquist plots of EGS-M1 and EGS-M2 electrodes obtained by applying a sine wave with amplitude of 5.0mV over the frequency range from 100 kHz to 0.01 Hz, and **(b)** The equivalent circuit model for the impedance respons.