Supporting information for

# Three-dimensional $MoS_x$ ($1 < x < 2$) Nanosheets Decorated Graphene Aerogel for Lithium-oxygen Batteries

Liangyu Li, [a] Chunguang Chen, [a] Junming Su, [a] Peng Kuang, [a] Yu Yao, [b] Tao Huang, [a] Aishui Yu *[a]

[a] Department of Chemistry, Shanghai Key Laboratory of Molecular Catalysis and Innovative Materials, Institute of New Energy, Collaborative Innovation Center of Chemistry for Energy Materials, Fudan University, Shanghai 200438, China. *E-mail: asyu@fudan.edu.cn; Fax: +86-21-51630320; Tel: +86-21-51630320

[b] Shanghai Institute of Space Power-Sources, Shanghai 200245, China.

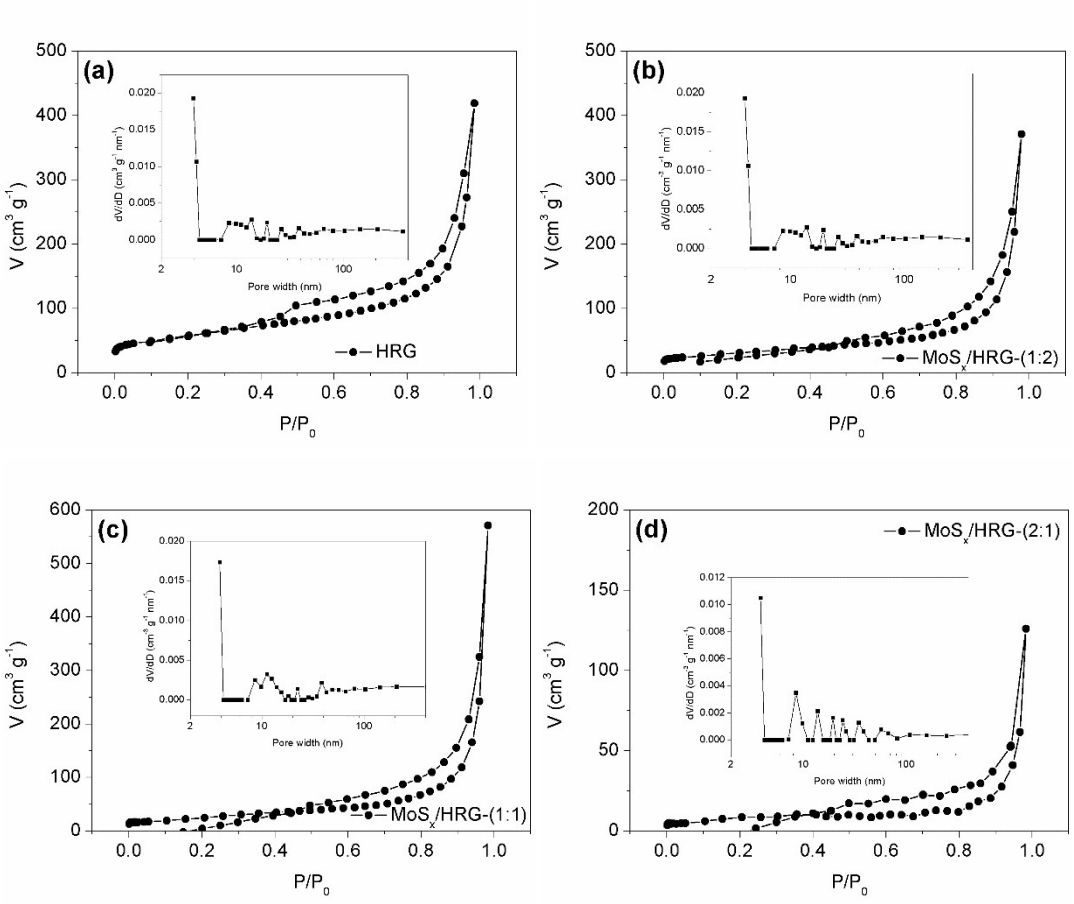


**Figure S1** Nitrogen adsorption-desorption isotherm and pore-size distribution (insert) of HRG, $MoS_x$/HRG-(1:2), $MoS_x$/HRG-(1:1) and $MoS_x$/HRG-(2:1).

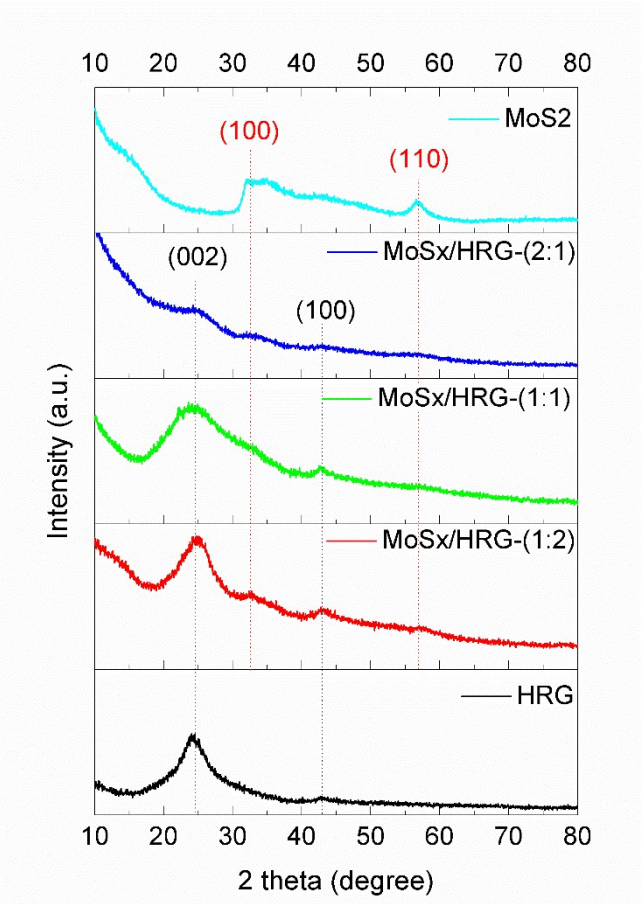


**Figure S2** The XRD patterns of HRG, MoSx/HRG-(1:2), MoSx/HRG-(1:1), MoSx/HRG-(2:1) and pure MoS2.

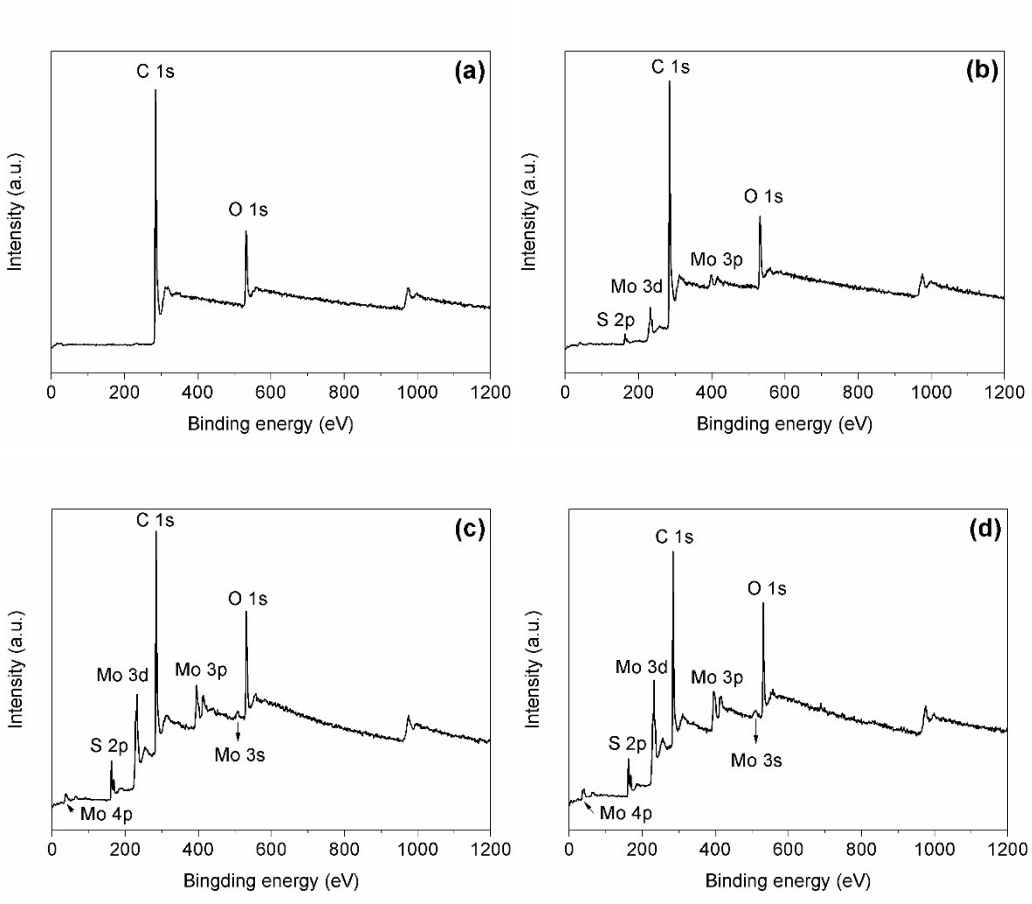


**Figure S3** XPS survey spectra of (a) HRG, (b) MoSx/HRG-(1:2), (c) MoSx/HRG-(1:1) and (d) MoSx/HRG-(2:1).

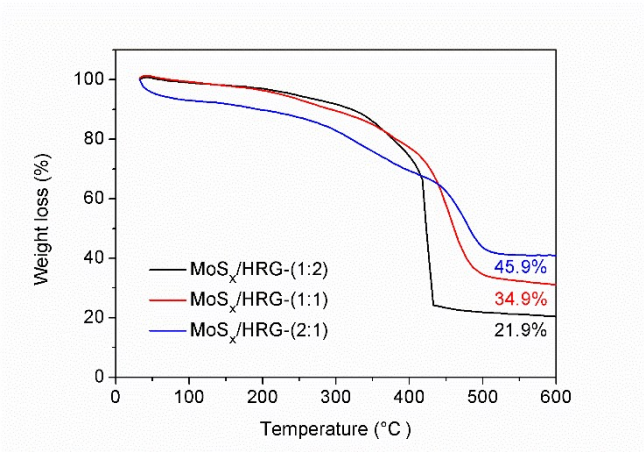


**Figure S4** TG curves in flowing oxygen of three $MoS_x$/HRG aerogels. The presented percentage of $MoS_x$ was gotten through calculations because of the oxidation of $MoS_x$ to $MoO_3$. The mole ratio of $MoS_2$ to $MoO_3$ and $Mo_2S_5$ to $MoO_3$ is 1:1 and 1:2. And the ratio of $MoS_2$, $Mo_2S_5$ and $MoO_3$ in each aerogel is based on Table 1.

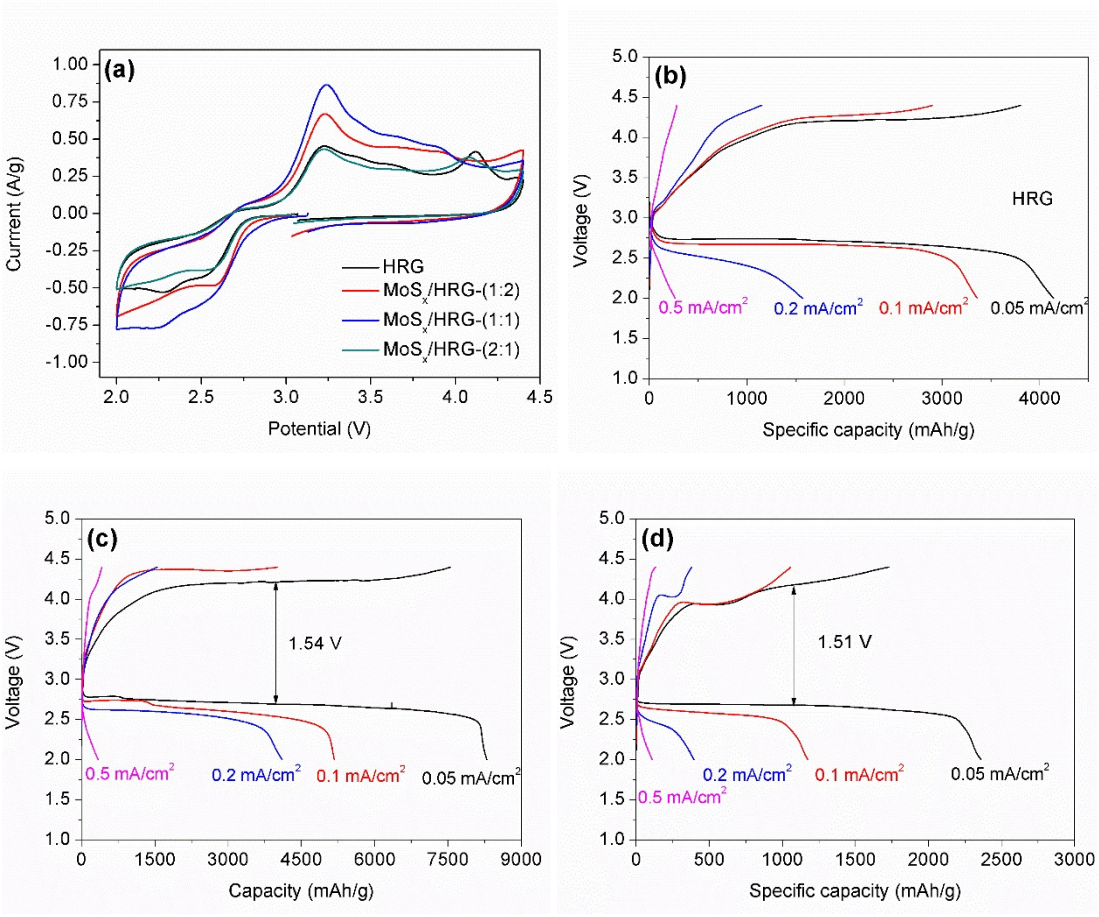


**Figure S5** (a) Cyclic voltammetry curves of four samples. Rate capacities of Li-$O_2$ batteries based on (b) HRG, (c) $MoS_x$/HRG-(1:1) and (d) $MoS_x$/HRG-(2:1).

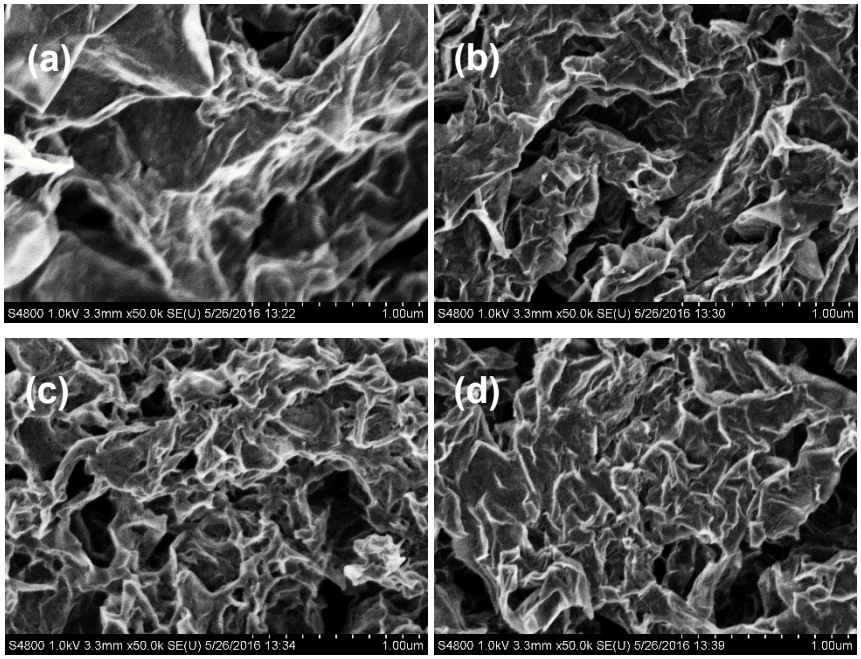


**Figure S6** SEM images of four samples after first discharge at current density of 0.5 mA $cm^{-2}$ (a) HRG, (b) $MoS_x$/HRG-(1:2), (c) $MoS_x$/HRG-(1:1) and (d) $MoS_x$/HRG-(2:1).

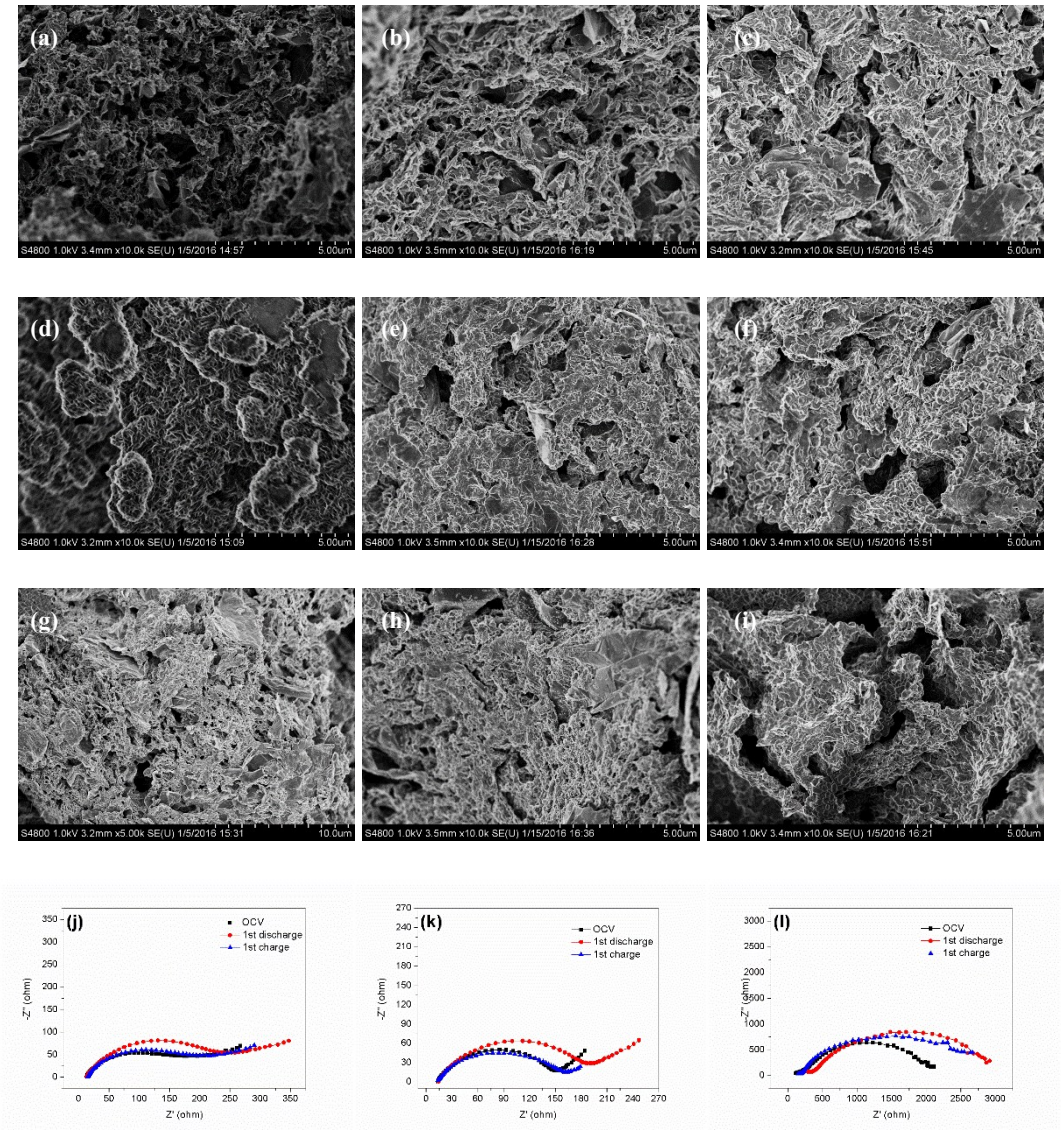


**Figure S7** SEM images of three samples at current density of 0.05 mA $cm^{-2}$ for HRG (a) pristine, (d) after first discharge, (g) after first charge, $MoS_x$/HRG-(1:1) (b) pristine, (e) after first discharge, (h) after first charge and $MoS_x$/HRG-(2:1) (c) pristine, (f) after first discharge, (i) after first charge. (j), (k) and (l) are electrochemical impedance spectra of the HRG, $MoS_x$/HRG-(1:1) and $MoS_x$/HRG-(2:1) electrodes in the first cycle, respectively.

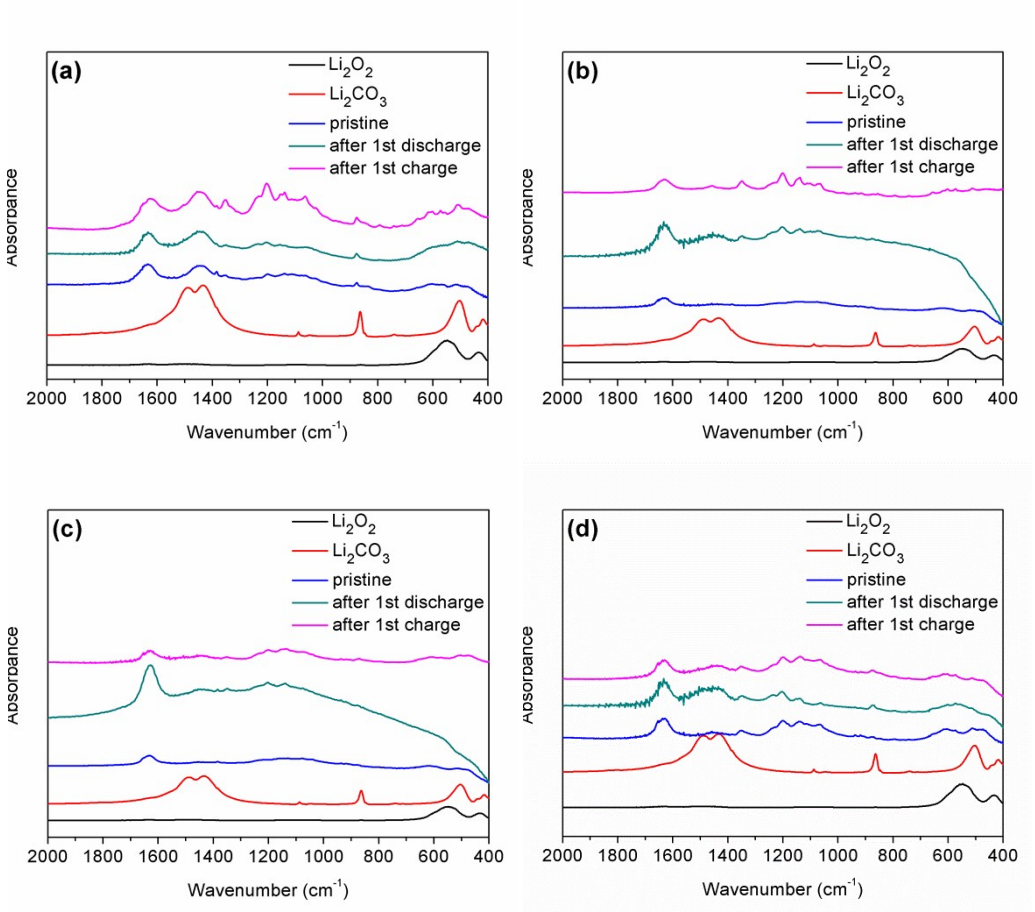


**Figure S8** FTIR spectra of the four samples' electrodes in the first cycle at current density of 0.05 mA $cm^{-2}$, (a) HRG, (b) $MoS_x$/HRG-(1:2), (c) $MoS_x$/HRG-(1:1) and (d) $MoS_x$/HRG-(2:1).

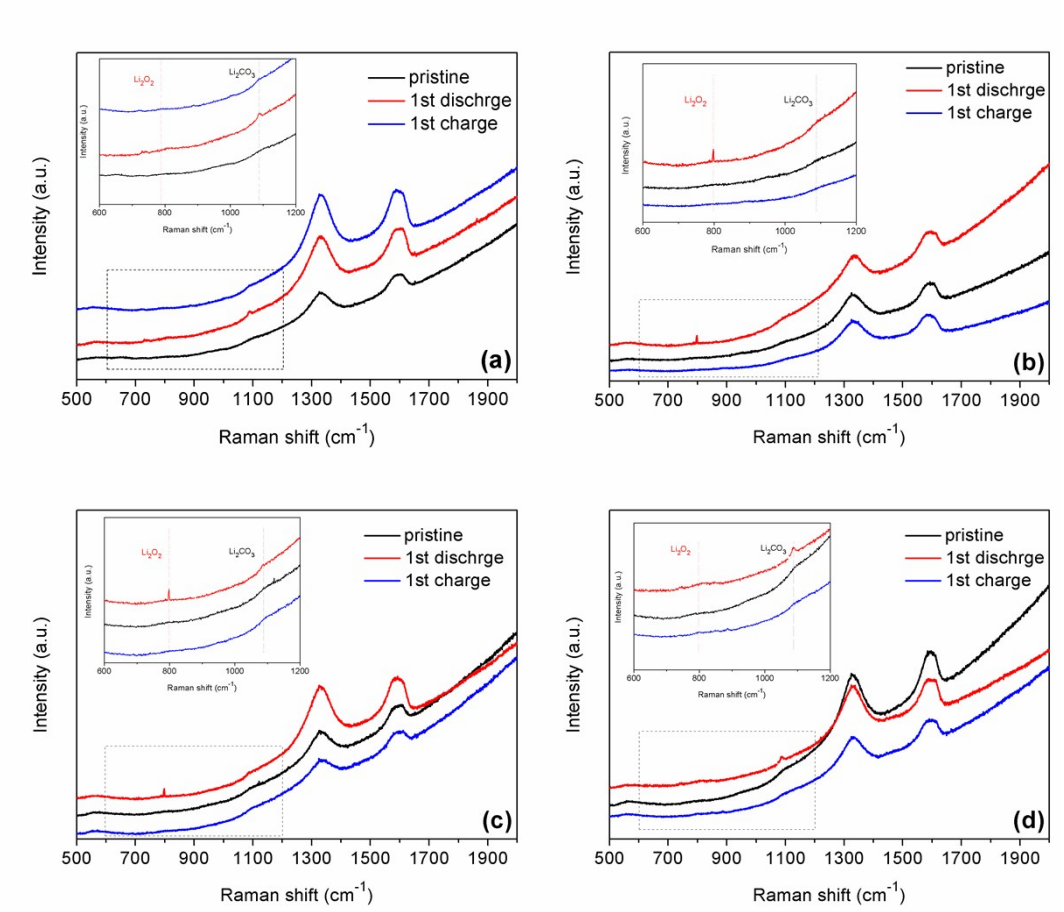


**Figure S9** Raman spectra of the four samples' electrodes in the first cycle at current density of 0.05 mA $cm^{-2}$, (a) HRG, (b) $MoS_x$/HRG-(1:2), (c) $MoS_x$/HRG-(1:1) and (d) $MoS_x$/HRG-(2:1).