Supporting Information

Preparation of Graphene

To a dispersion of GO (100 mg) in water (50 mL), citric acid and poly(ethylene glycol) (PEG) mixed in a 1:3 molar ratio (0.25 g citric acid, 1.56 g PEG) in 20 mL of water were added. The solution was placed in a 100 mL Teflon lined autoclave and heated in a vacuum oven at 180 °C for 26 h. The resulting Graphene was filtered and washed with water, dried and stored in an inert atmosphere. The weight of the resulting product (Neat Graphene) is 33.2 % of the total weight of the MoO_2/Graphene composite and therefore in the composite, the MoO_2:Graphene proportion is 2:1. Similarly, two more composites with different MoO_2:Graphene proportions were also prepared for optimizing the MoO_2:Graphene proportion. When70 mg and 130 mg of GO were used (all other contributions remaining the same), neat Graphene was found to be 21% and 40.5% of the total weight of the MoO_2/Graphene composite. So three MoO_2/Graphene composites with MoO_2:Graphene in 2:1, 3.76:1 and 1.45:1 ratios were prepared.

Preparation of MoO_2

To a dispersion 0.558 mM ammonium heptamolybdate ($(NH_4)_6Mo_7O_{24}.4H_2O$) in water (50 mL), citric acid and poly(ethylene glycol) (PEG) mixed in a 1:3 molar ratio (0.25 g citric acid, 1.56 g PEG) in 20 mL were added. The solution was placed in a 100 mL Teflon lined autoclave and heated in a vacuum oven at 180 °C for 26 h. The resulting product designated as neat MoO_2 was filtered and washed with water, dried and stored in an inert atmosphere.

Preparation of MoO_2/Graphene oxide

To a dispersion of GO (100 mg) in water (50 mL), 0.558 mM ammonium heptamolybdate ($(NH_4)_6Mo_7O_{24}.4H_2O$) in water (20 mL) and 1.56 g of poly(ethylene glycol) (PEG) were added.

The solution was placed in a 100 mL Teflon lined autoclave and heated in a vacuum oven at 180 °C for 26 h. The resulting product labeled as MoO_2/Graphene oxide composite was filtered and washed with water, dried and stored in an inert atmosphere.

Calculation of theoretical specific capacity of MoO_2/Graphene composite:

- Theoretical specific capacity of MoO_2 = 838 mAh g^{-1} (for 4 Li^+ insertion/deinsertion)
- Theoretical specific capacity of Graphene = 623 mAh g^{-1}

Theoretical specific capacity of MoO_2/Graphene = 66.8 % MoO_2 + 33.2 % Graphene

= 66.8 % * 838 + 33.2 % * 623

= 766.8 mAh g^{-1}

The galvanostatic charge-discharge characteristics of the MoO_2/Graphene composites with MoO_2:Graphene weight ratios of 2:1, 3.76:1 and 1.45:1 are shown below in the Fig. S1. The charge-discharge curves recorded at a current density of 540 mA g^{-1} (Fig. S1a) for the first cycle of MoO_2/Graphene in 2:1, 3.76:1 and 1.45:1 proportions show charge/discharge capacities, respectively, of 703/1455, 535/988 and 552/1094 mAh g^{-1}. As can be observed from Fig. S1a, the MoO_2/Graphene composite (2:1) shows a high initial reversible capacity of 700 mAh g^{-1} and the MoO_2/Graphene composite (3.76:1) shows an initial capacity of 535 mAh g^{-1}. The low graphene content in the MoO_2/Graphene composite (3.76:1), renders the material less conducting which is responsible for the observed poor capacity. On the other hand, in the MoO_2/Graphene composite (1.45:1), the active material (MoO_2) concentration is low, which can cause the re-stacking of graphene layers, and therefore a low capacity (552 mAh g^{-1}) is observed. It is obvious that the MoO_2/Graphene composite (2:1), has an optimal balance of the two components, which

results in good electrochemical performance. After 50 cycles the MoO_2/Graphene composites in 2:1, 3.76:1 and 1.45:1 shows reversible capacities of 760, 575 and 320 mAh g^{-1} (Fig. S1b).

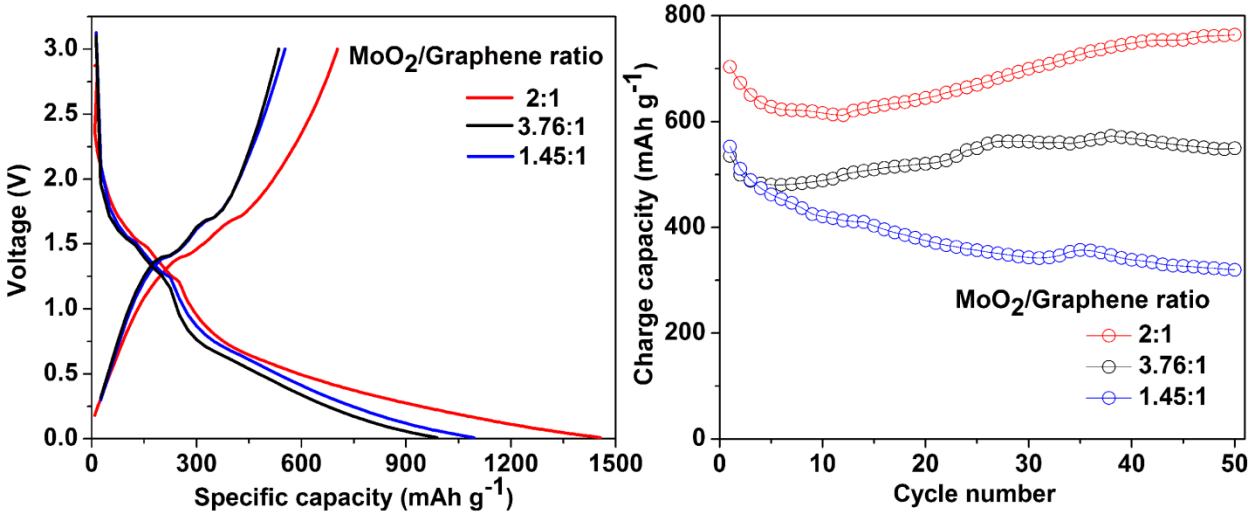

Fig. S1. (a) Galvanostatic charge-discharge curves of MoO_2/Graphene composite with different proportions. (b) cyclability of the composites; all curves recorded at a current density of 540 mA g^{-1}.

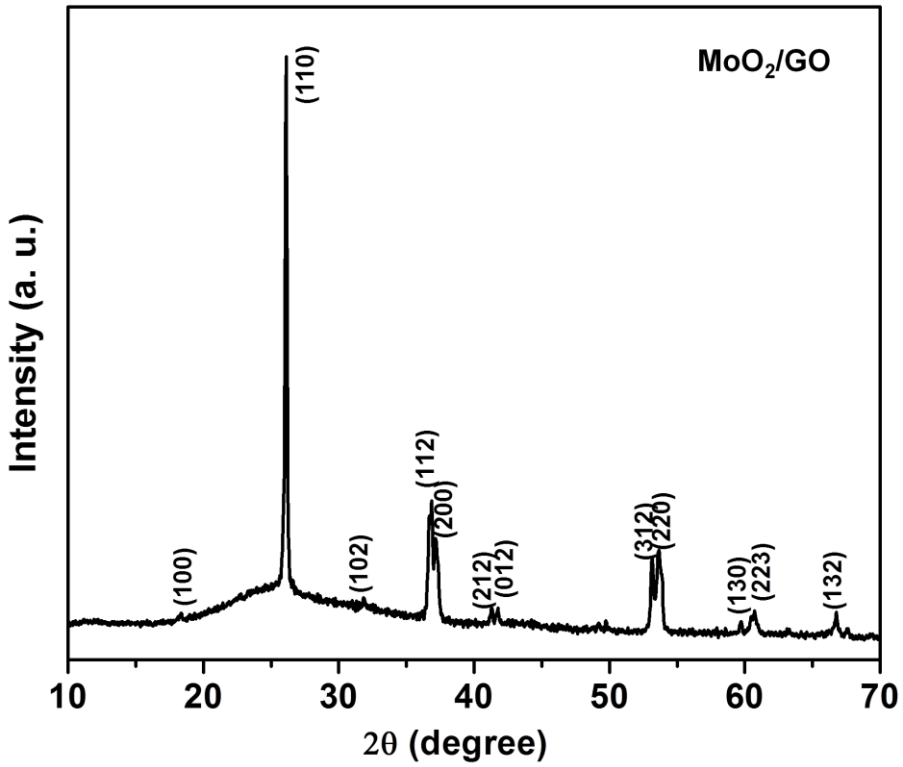

Fig. S2. XRD pattern of MoO_2/Graphene oxide composite

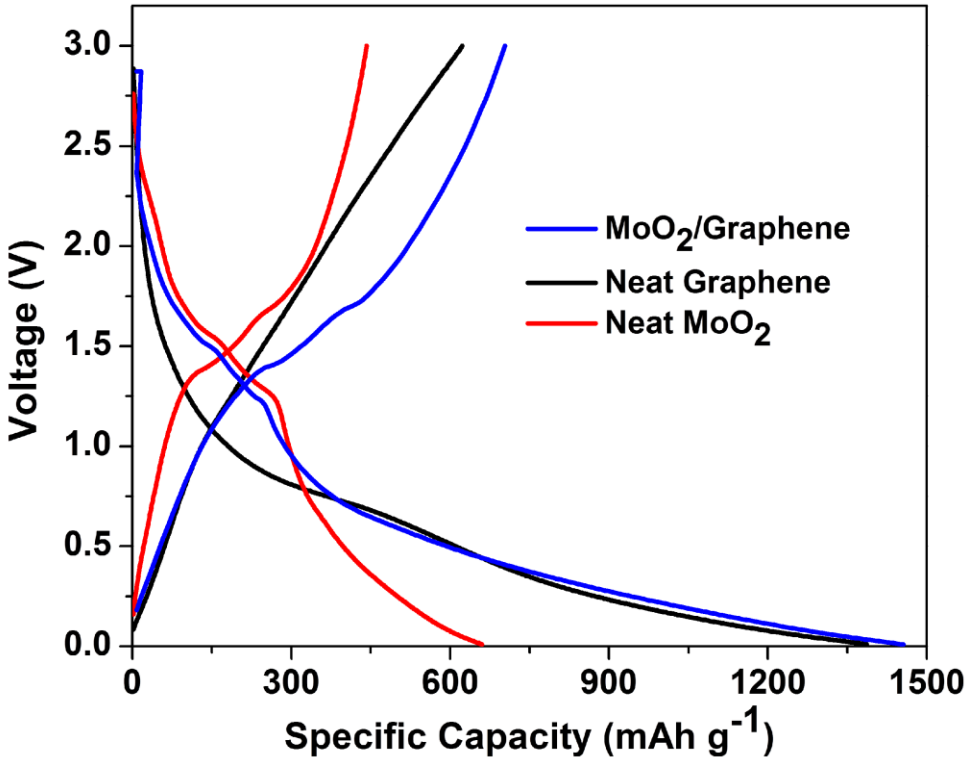

Fig. S3. Galvanostatic charge-discharge curves for the first cycle of Neat MoO_2, Neat Graphene and MoO_2/Graphene composite at current densities of 200, 200 and 540 mA g^{-1}, respectively.

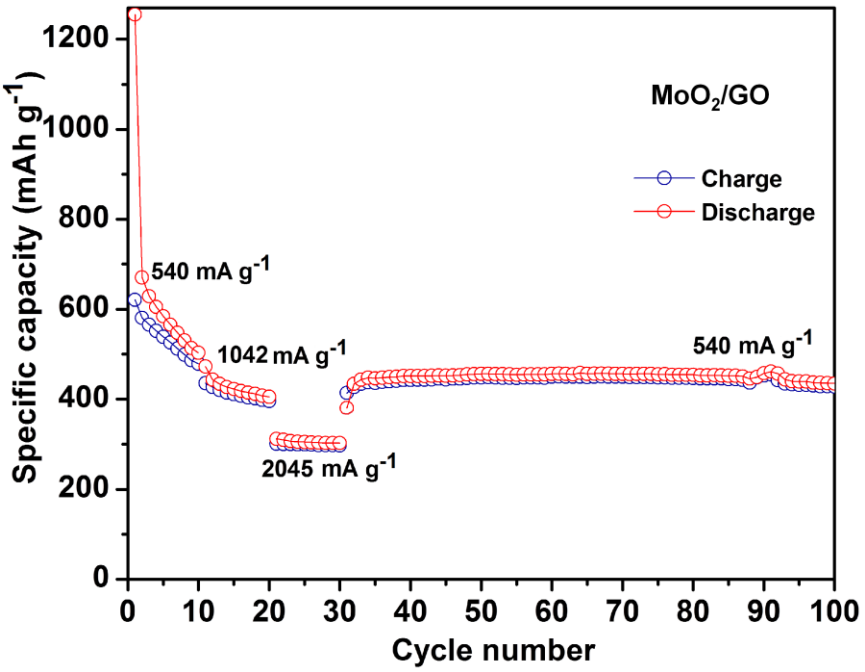

Fig. S4. Rate capability of MoO_2/GO composite.

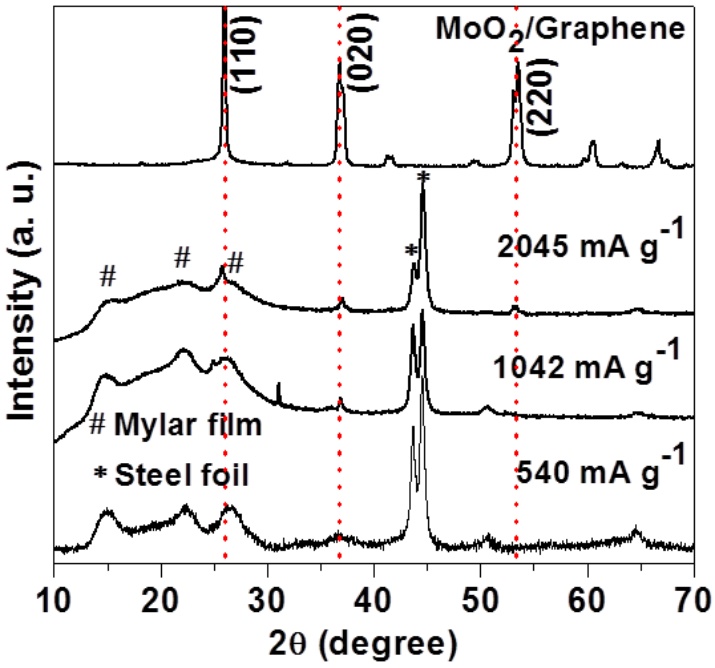

Fig. S5. .*Ex-situ* XRD patterns of MoO_2/Graphene electrode after subjecting it to 50 charge–discharge cycles, at different C-rates of 540, 1042 and 2045 mA g^{-1}.