Supplementary file

Carbon sheathed molybdenum nitride nano-particles anchored on reduced graphene oxide as high capacity sodium-ion battery anodes and supercapacitors.

Characterization and Testing

Morphological characterization of the nanostructures was carried using a field-emission scanning electron microscopy (FE-SEM, Nova NanoSEM 230 FEI operating at 10kV, no metal coating was applied to the samples), high resolution transmission electron microscopy (HRTEM; JEOL, JEM-2011, 200 kV), structural analysis by Raman spectra (LabRAM HR UV/vis/NIR Horiba Jobin-Yvon, France) and chemical analysis by X-ray photoelectron spectroscopy (AXIS SUPRA, using Al Kα X-ray sources). The XPS spectra were curve fitted with a mixed Gaussian-Lorentzian shape using the freeware XPSPEAK version 4.1. Surface area and porosity were measured by Nitrogen adsorption and desorption isotherms at 77K using a BEL Japan Inc. Belsorp Mini II Surface Area and Pore Size Analysis system.

Electrochemical tests were conducted using CR2032 coin-type test cells assembled in argon- filled glove box. Working electrodes were prepared with active materials and poly(acrylic acid) as the binder (mass ratio of 85: 15) were added to ethanol and mixed into a homogeneous slurry. The slurry was cast on a fresh glass plate cleaned with piranha solution and dried at 100 °C in vacuum for 5 h. The coin cells were assembled with pure sodium foil as counter electrode, a glass fiber as separator, 1M $NaClO_4$ in ethylene carbonate/propylene carbonate (1:1 v/v) as electrolyte. The working electrodes were composed of 0.5 g of active material and a sodium foil separated by a micro-porous Celgard 2400 membrane. Galvanostatic charge-discharge cycling tests were performed using an WBCS 3000, Won-A-Tech, Korea battery testing system in the voltage range between 0.001 - 3 V).

Figure S1 HRTEM micrograph of carbon encapsulated molybdenum nitride anchored on reduced graphene oxide.

Figure S2 XRD of graphene oxide and Mo_2N@C-rGO

Figures S3 HAADF micrograph of carbon coated molybdenum nitride carbon coated molybdenum nitride anchored on reduced graphene oxide.

Figure S4 STEM-HAADF elemental map showing distribution of molybdenum, carbon and nitrogen moieties.

Figure S5 SEM micrographs of carbon nanotubes anchored on reduced graphene oxide synthesized from diazonium grafted graphene oxide using palladium as the catalyst.

Figure S6 SEM micrographs of carbon nanotubes anchored on reduced graphene oxide synthesized from diazonium grafted graphene oxide using iron as the catalyst.

Figure S7 Pore size distribution of graphene oxide and Mo_2N@C-rGO.

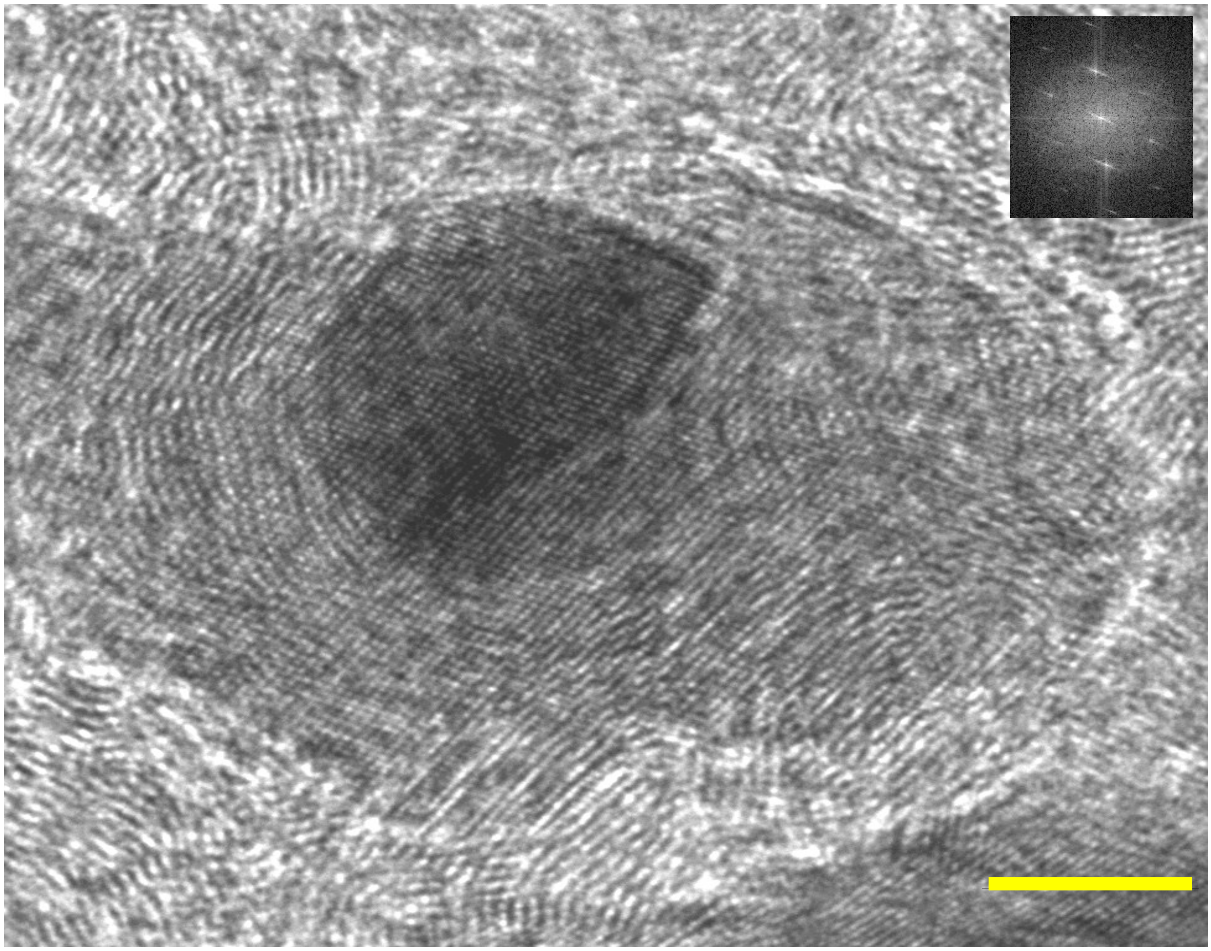

Figure S1: HRTEM micrograph of carbon encapsulated molybdenum nitride anchored on reduced graphene oxide. Scale bar is 10 nm and insert is FFT pattern.

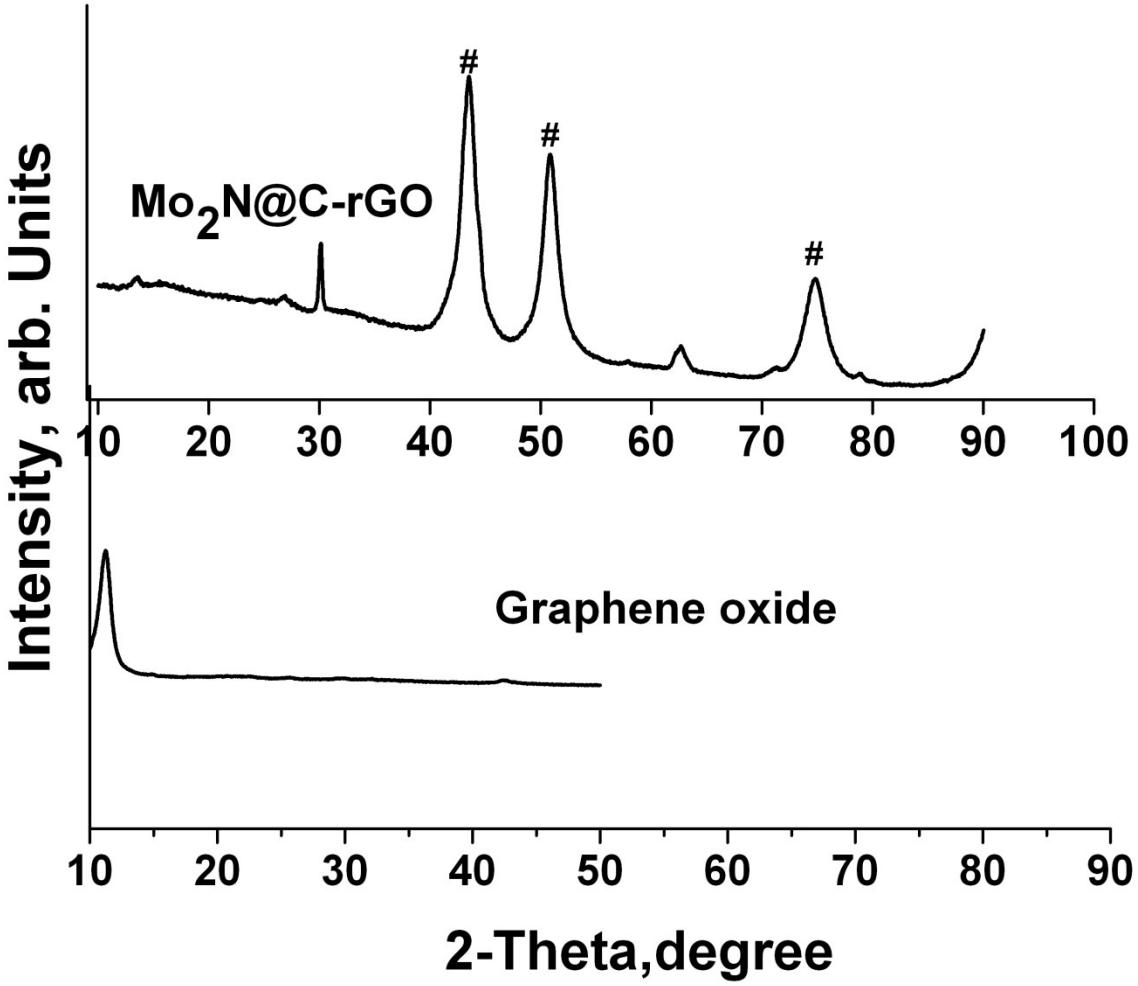

Figure S2 XRD of graphene oxide and Mo_2N@C-rGO.

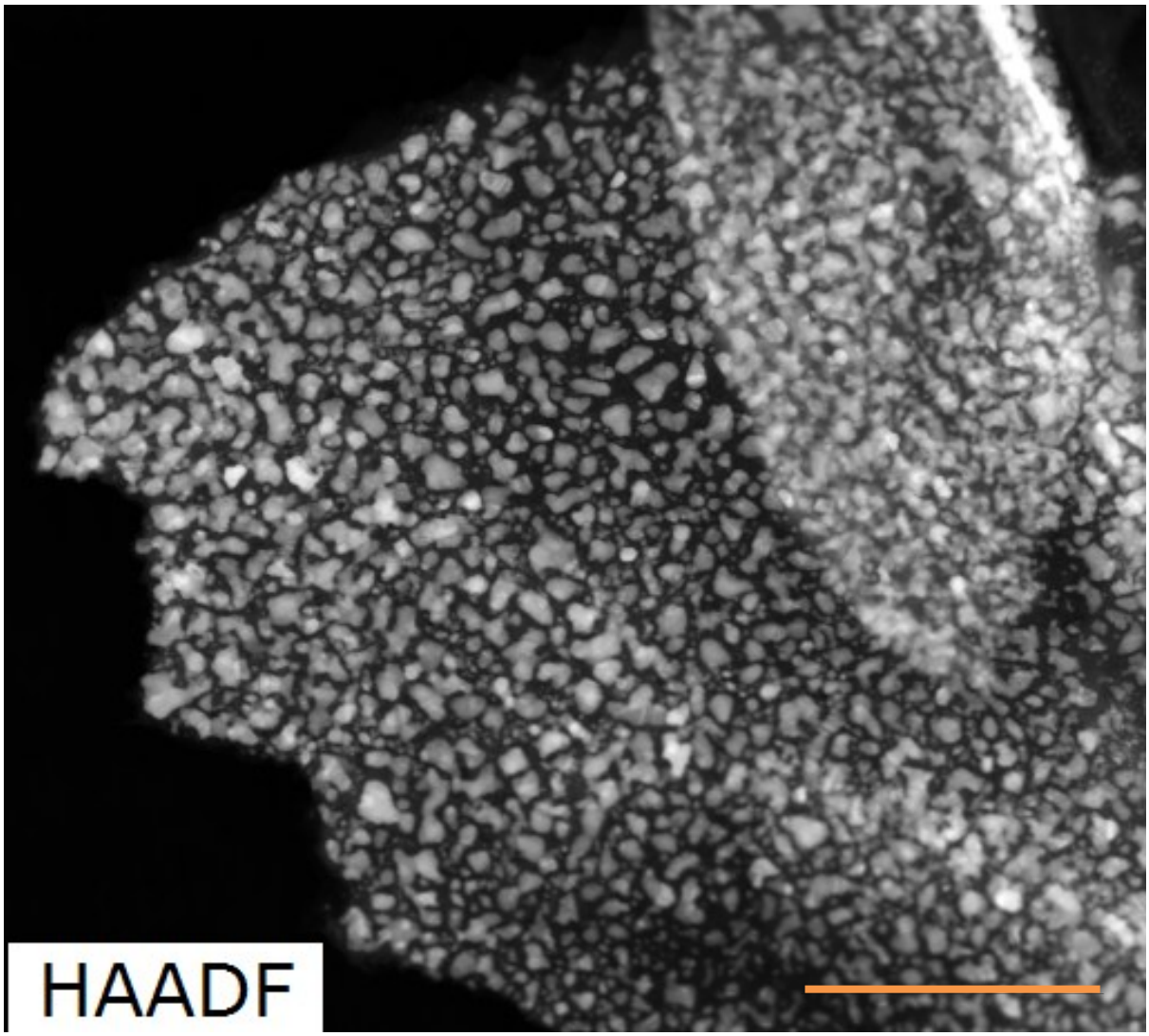

Figure S3: HRTEM-HAADF micrograph of carbon coated molybdenum nitride carbon coated molybdenum nitride anchored on reduced graphene oxide. Scale bar is 300 nm

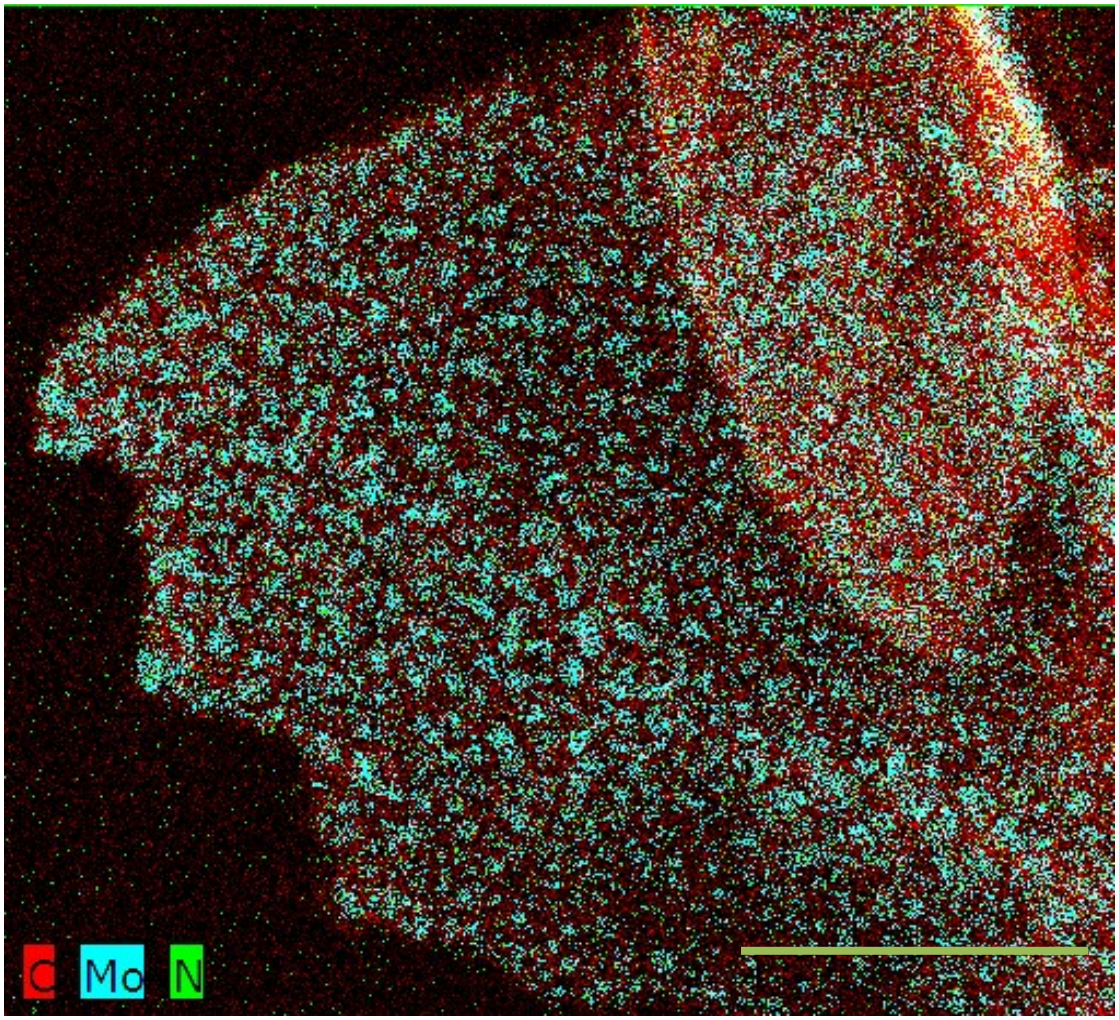

Figure S4: STEM-HAADF elemental map showing distribution of molybdenum, carbon and nitrogen moieties. Scale bar is 300 nm.

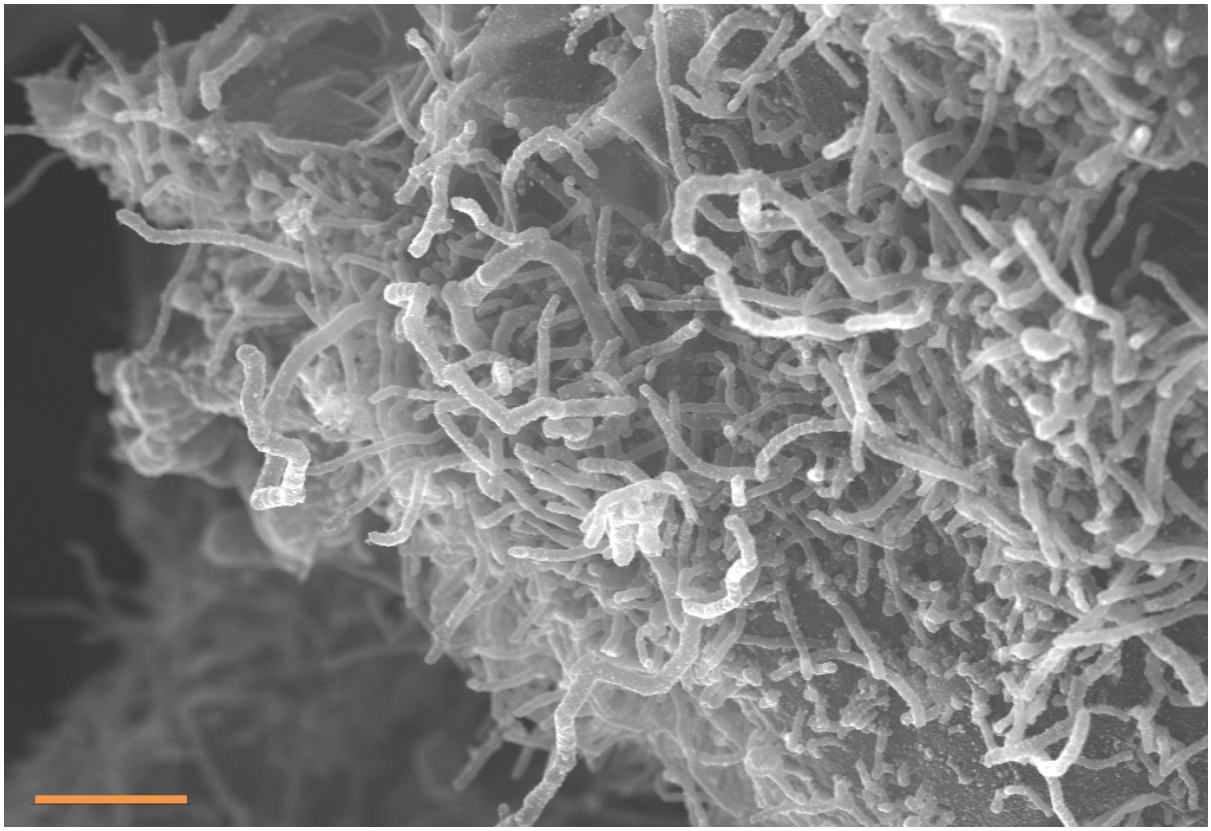

Figure S5: SEM micrographs of carbon nanotubes anchored on reduced graphene oxide synthesized from diazonium grafted graphene oxide using palladium as the catalyst. Scale bar is 2 μm

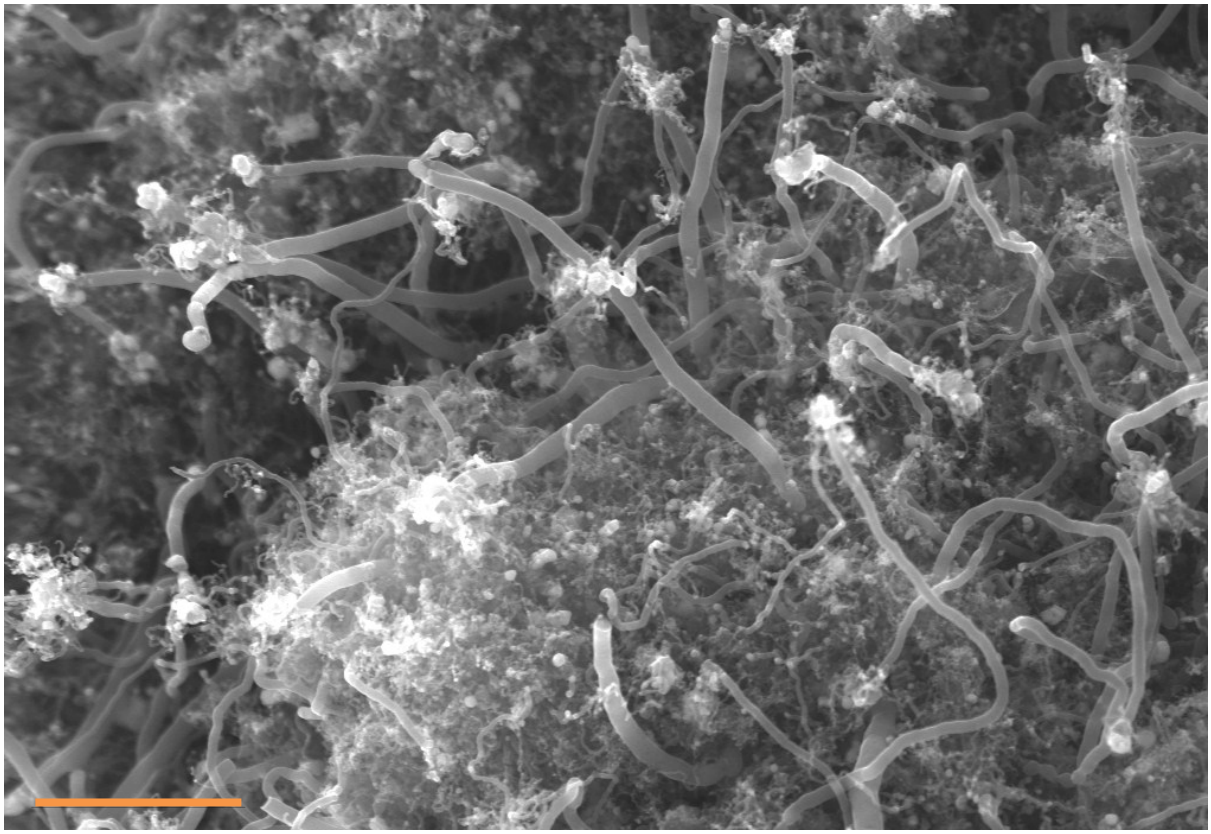

Figure S6: SEM micrographs of carbon nanotubes anchored on reduced graphene oxide synthesized from diazonium grafted graphene oxide using iron as the catalyst. Scale bar is 3 μm.

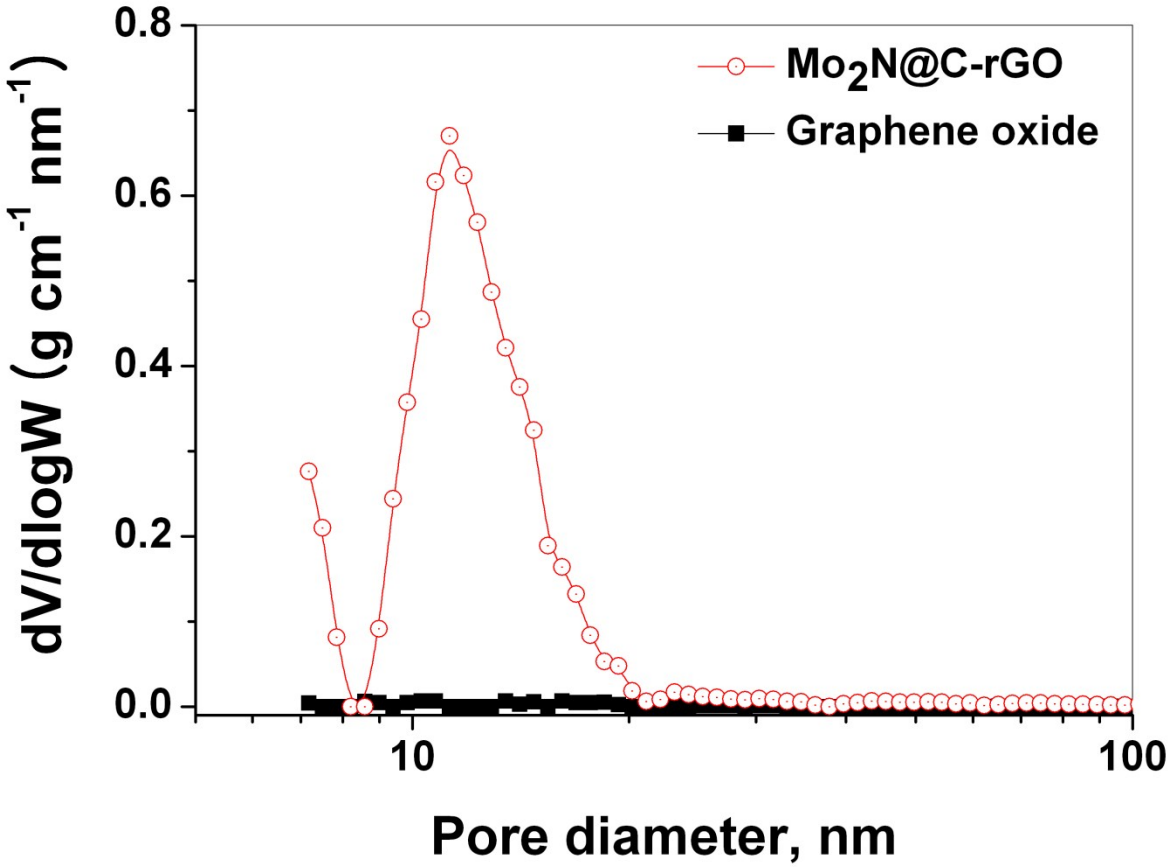

Figure S7: Pore size distribution of graphene oxide and Mo_2N@C-rGO