Supporting Information

One-pot synthesis of thin $Co(OH)_2$ nanosheets on graphene and their high activity as a capacitor electrode

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Experimental Section

1. Materials

Graphite powder and sodium hydroxide (NaOH, 98 %) were purchased from SAMCHUN PURE CHEMICAL CO., LTD, Korea. Sodium dodecylsulfonate (SDS, 99+ %) were obtained from Sigma-Aldrich. Cobalt (II) chloride hexahydrate ($CoCl_2$ $6H_2O$, 95 %) were purchased from HAYASHI PURE CHEMICAL CO., LTD, Japan. Distilled water was used in the preparation of aqueous solution.

2. Synthesis of graphene flakes functionalized surfactants

In typical synthesis, 2 g of graphite powder was ultrasonicated with 50 ml of water for 1h. And then, the prepared graphite powder solution had stirred in 10 mM SDS for overnight at room temperature.

3. Synthesis of $Co(OH)_2$/graphene composites

The prepared graphene flakes solution (20 ml), was mixed in the Co salt (20 mM, 20ml), and 100 ul of 1.5 M NaOH. This mixture solution was stirred for a few minutes and transferred to a 50 ml Teflon-line autoclave, sealed and heated at 120 ˚C for 2 hours. The product was collected, washed with water and ethanol three times and dried in an oven at 50 ˚C.

4. Characterization

Transmission Electron Microscope (TEM) images were taken using an FEI Morgagni™ electron microscope operated at an acceleration voltage of 300 kV. X-Ray diffraction (XRD) patterns were obtained with a Rigaku Ultima III diffractometer equipped with a rotating anode and a Cu-Kα radiation source (λ=0.15418 nm). Inductively Coupled Plasma-Optical Emission Spectrometer (ICP-OES) were measured by the OPTIMA 5300DV, PerkinElmer (U.S.A).

Electrochemical Section

1. Electrode synthesis

A $Co(OH)_2$/graphene powder was loaded onto a 110 μm thick Ni foil by mixing 10 wt% polytetrafluoroethylene (PTFE; 60 wt% dispersion in water, Sigma Aldrich) as binder. The mixture was homogenized in an agate mortar, formed into electrodes by rolling the mixture into 50 μm thick sheets. The mixture-coated electrode was dried in an oven at 80 °C for 6 hours. To compare typical type of electrode contained active material, conductive carbon black, and binder, $Co(OH)_2$/graphene mixed with carbon electrode was also prepared on a Ni foil in the same way. A $Co(OH)_2$/graphene mixed with carbon electrode was prepared by the active material ($Co(OH)_2$/graphene), Super P carbon black (MMM carbon), and PTFE binder in 70:20:10 weight ratio.

2. Characterization

The electrochemical properties were carried out using a standard three-electrode cell at room temperature (23±1 ºC) for using a computer-controlled potentiostat (Princeton Applied Research, VSP). A saturated Ag/AgCl electrode and a platinum coated titanium mesh (2.5 cm^2 in size) were used as reference electrodes and a counter electrode, respectively. A $Co(OH)_2$/graphene electrode of the size 10×30 mm^2 (exposed area 10×10 mm^2) were used as working electrode, and 2 M KOH as the electrolyte. Before electrochemical analysis, the electrolyte was de-aerated by nitrogen gas for 5min. Cyclic voltammograms (CVs) were recorded between -1.0 and 0.5V vs. Ag/AgCl at a scan rate 100 mV/s. The constant current charge/discharge reaction was carried out chrono-potentiometrically at a current varied from 10 to 35 A/g. Electrode was discharged to -0.45 V (at the fully discharged state) in the first cycle and charged to 0.45V (at the fully charged state) in the second cycle. The capacitance (C) of an electrode can be calculated from the equation

$$C = \frac{dQ}{dV} = \frac{I_{cons}}{(dV/dt)} \qquad (1)$$

where Q is the charge on the electrode, I_{cons} is the constant current in ampere, and dV/dt was calculated from the slop of the discharge curve in Volt per second (V/s). The specific capacitance (F/g) of $Co(OH)_2$/graphene and $Co(OH)_2$/graphene mixed with carbon electrodes were obtained by dividing its respective weight.

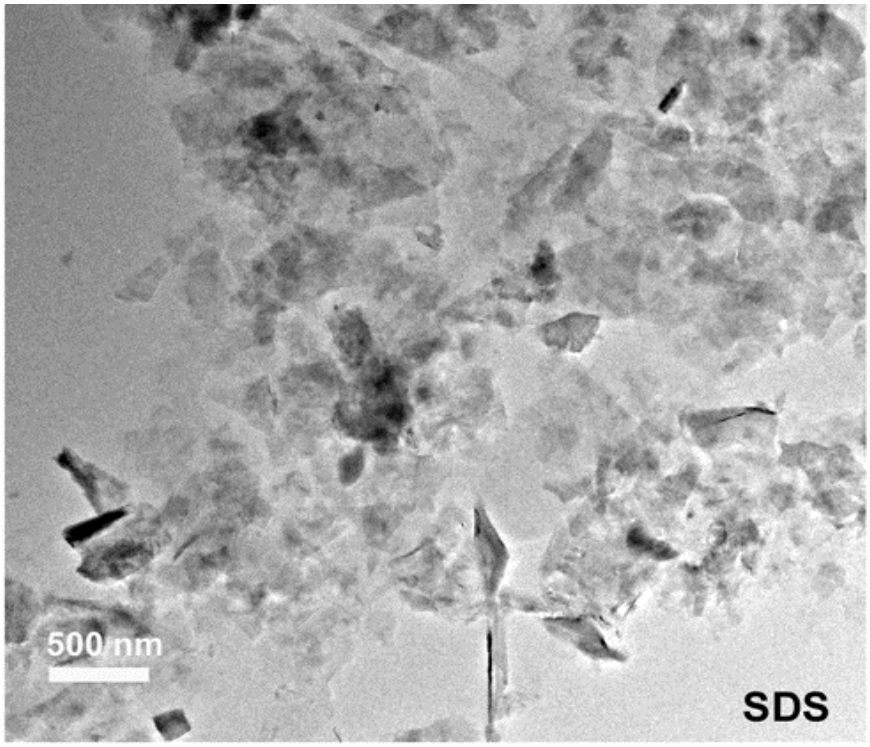


Fig. S1. TEM image of SDS-functionalized grapheme flakes.

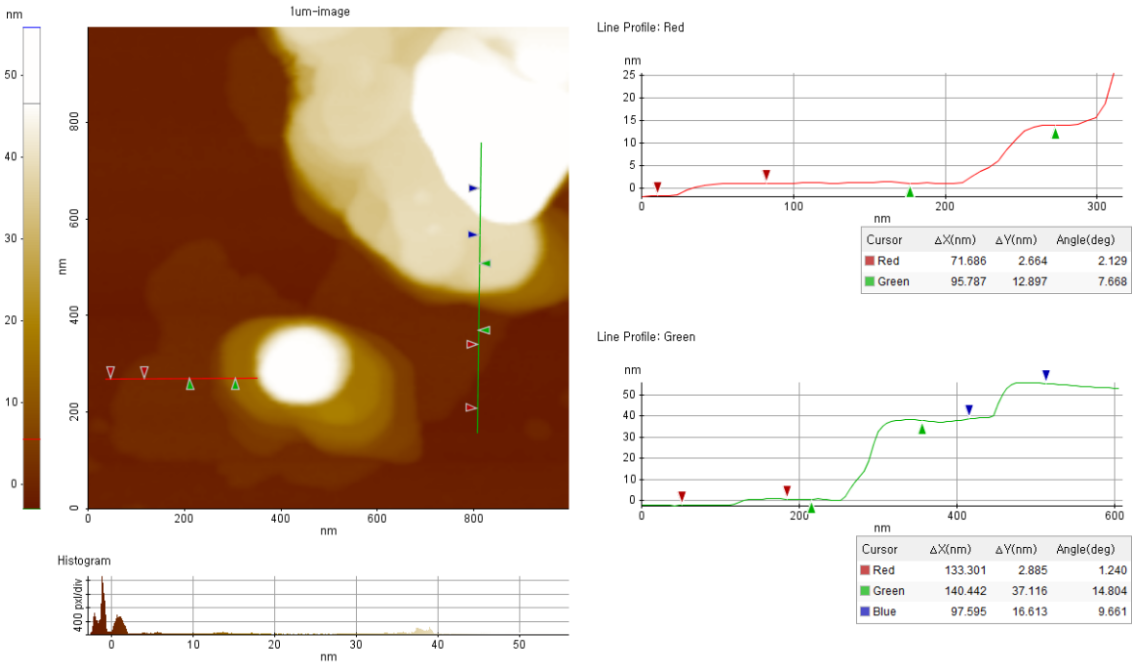
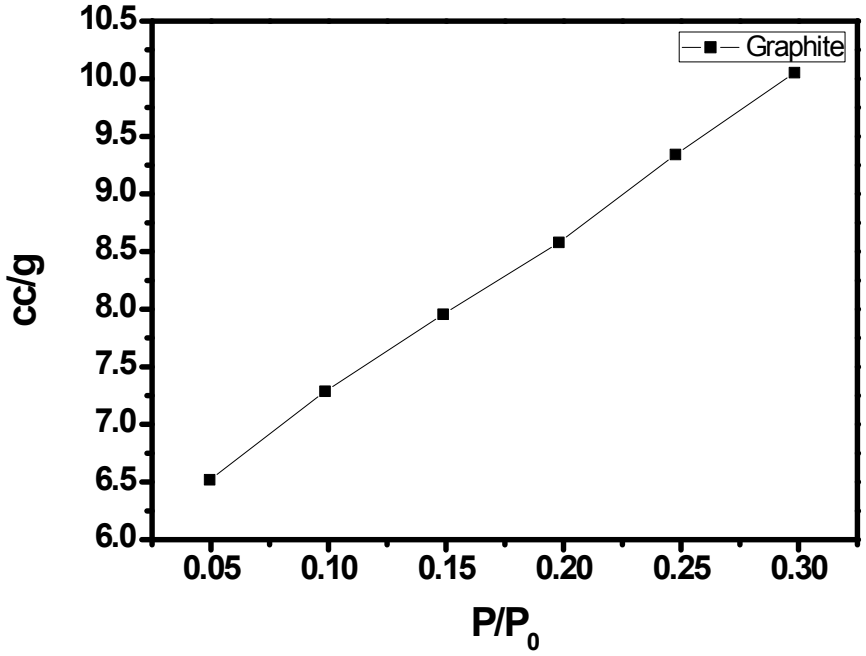


Fig. S2. AFM result of $Co(OH)_2$/grapheme composite.



Surface area : 31.375 m^2/g

Fig. S3. Surface area of graphite

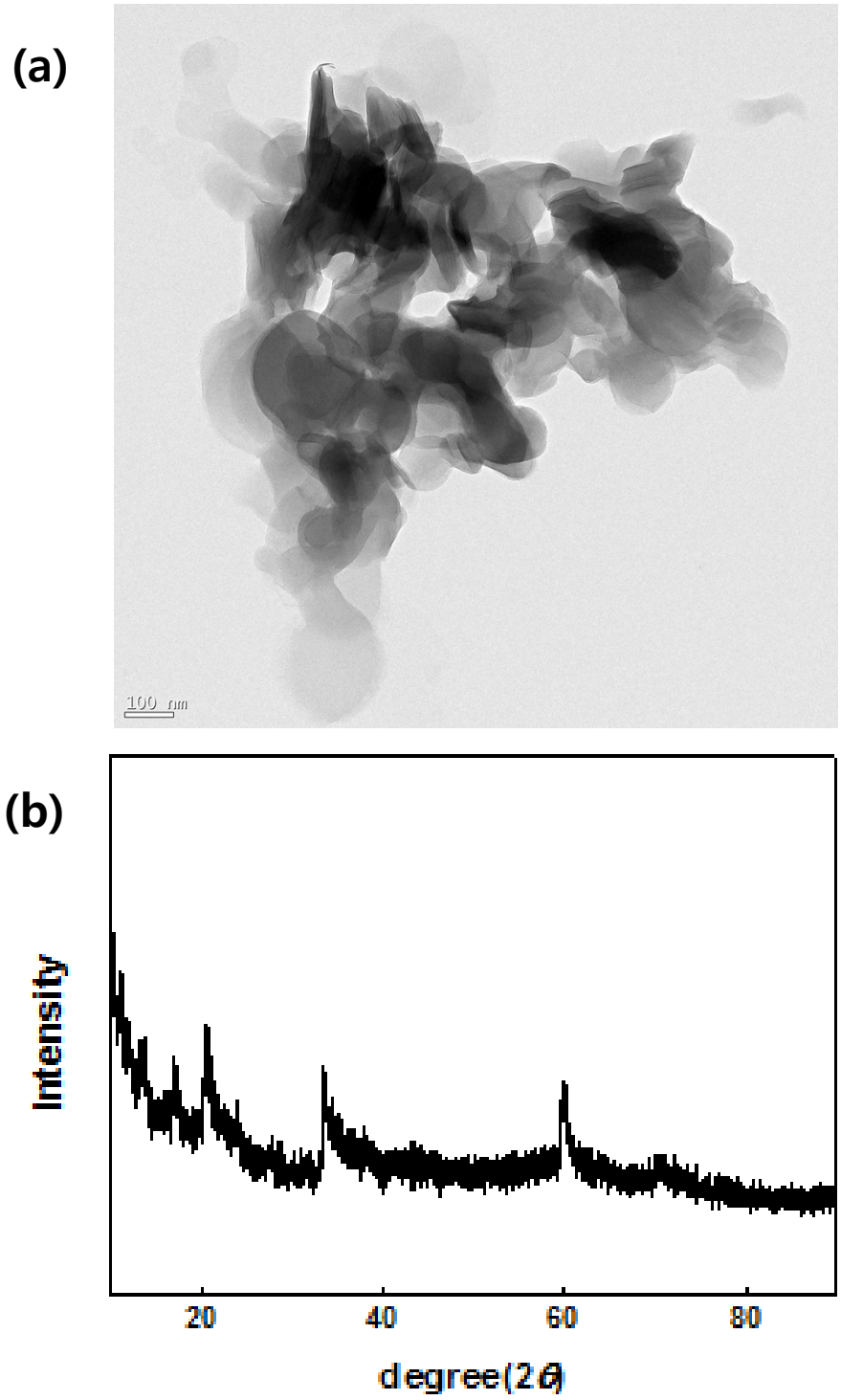


Fig. S4. TEM image (a) and XRD pattern (b) of $Co(OH)_2$ without graphene flakes

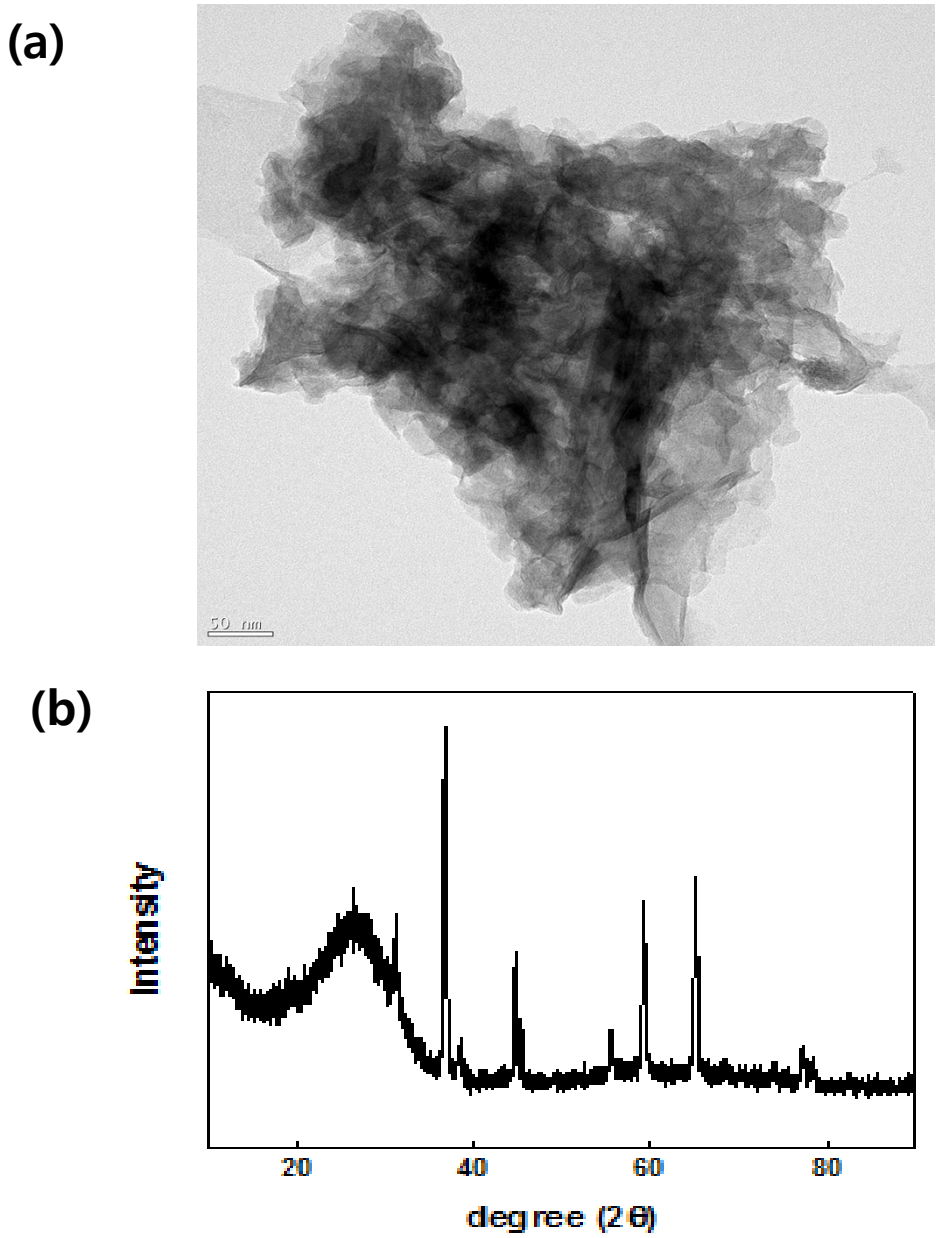


Fig. S5. TEM image (a) and XRD pattern (b) of Co_3O_4 with GO.