

Electronic Supplementary Information on

Two-dimensional Cr₂O₃ and Interconnected Graphene-Cr₂O₃ Nanosheets: Synthesis and Their Applications in Lithium Storage

Guixia Zhao,^a Tao Wen,^a Juan Zhang,^b Jiaying Li,^a Huanli Dong,^b Xiangke Wang,^{*a} Yu-Guo Guo^b
and Wenping Hu^{*b}

^aKey Laboratory of Novel Thin Film Solar Cells, Institute of Plasma Physics, Chinese Academy of
Science,

P.O. Box 1126, Hefei, 230031, China

^bBeijing National Laboratory for Molecular Sciences, Institute of Chemistry, Chinese Academy of
Sciences, Beijing 100190, P.R. China

1. Experimental sections

1.1. Preparation of graphene-based Cr₂O₃ nanomaterials

Firstly, graphene oxide (GO) was synthesized by a modified Hummer's method. Then the GO suspension and Na₂CrO₄ solution were mixed with different ratios. In the synthesis of pure Cr₂O₃ nanosheets (CN), the initial mass ratio of GO and Na₂CrO₄ was 1:5. In other graphene/Cr₂O₃ composites, the initial mass ratios of GO and Na₂CrO₄ were varied at 1:1 and 1:3. The mixed solutions (75 mL) were stirred for 10 minutes and then the pH was adjusted to 2.0 by adding small amounts of hydrochloric acid. The resulted suspension was aged for several hours at 60 °C in water bath before transferred to a Teflon-lined stainless steel autoclave (100 mL in capacity) for the 24 h-reaction at 150 °C. The resulting product was collected by centrifugation, washed with deionized water and absolute ethanol for several times and dried at room temperature under vacuum for 24 h. The dried samples (i.e. P-CN, P-GCN1 and P-GCN3) were then calcinated in Ar at 700 °C for 1 h. The resulted pure Cr₂O₃ and composites were denoted as CN, GCN1 and GCN3 according to the

reactants ratios.

1.2. Characterizations of Cr₂O₃ and graphene-Cr₂O₃ nanosheets

Specimens were characterized using XRD on a D/max2500 with a Cu K α source ($\lambda = 1.541 \text{ \AA}$). TEM, SAED and EDS analysis were performed on a JEM-2010. SEM images were obtained with a XL-30 ESEM. Raman spectra were recorded using a LabRamHR. The laser excitation was provided by a regular model laser operating at 514.5 nm. XPS was analyzed by an ESCALAB 250. TG and DTA curves were measured by using a Shimadzu TGA-50 thermogravimetric analyzer from room temperature to 800 °C with heating rate of 10 °C/min and Ar flow rate of 50 mL/min.

1.3. Electrochemical measurements

The electrochemical properties of the products were evaluated using CR2032-type coin cells. The working electrodes were made by coating a slurry which contained 80 wt% active material, 10 wt% poly(vinylidene fluoride) (PVDF) (as a binder) and 10 wt% super P (as a conductive agent). The slurry was uniformly plastered on a copper foil current collector followed by drying at 80 °C under vacuum overnight. Then the electrodes assembled into half cells in an Ar-filled glove box using Li foil as the counter electrodes and the polypropylene microporous films (Celgard 2300) as the separators. The electrolyte was 1 M LiPF₆ dissolved in ethylene carbonate (EC)-dimethyl carbonate (DMC) with volume ratio of 1: 1. The galvanostatic charge-discharge performance was measured with a LAND test system at room temperature, and the voltage range was from 0.005 to 3.0 V (vs. Li/Li⁺), with different constant currents. Electrochemical impedance spectroscopy (EIS) were recorded on a PARSTAT 2273 advanced electrochemical system over the frequency range of 0.1 Hz to 100 kHz.

2. C 1s XPS spectra of P-GCN3 and GCN3

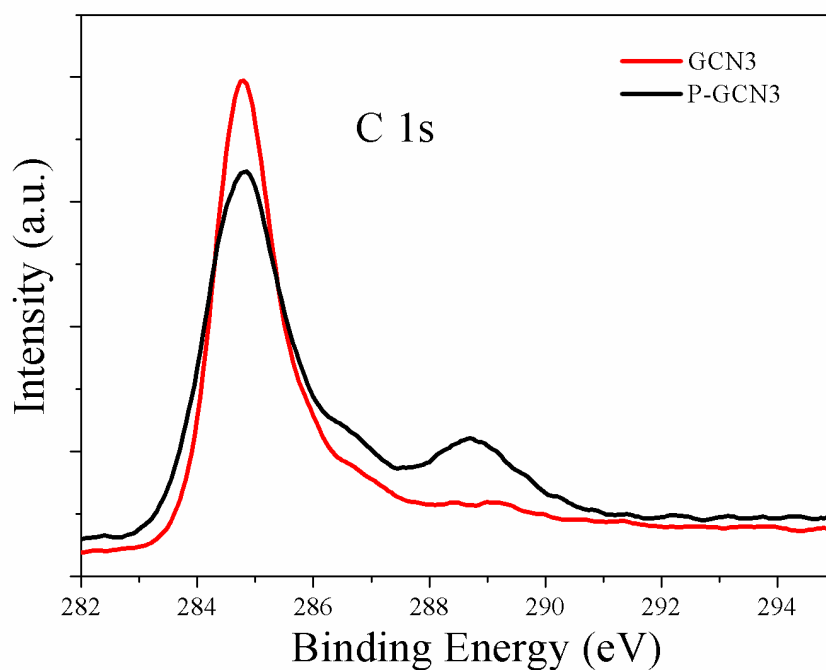


Figure SI 1. C 1s XPS spectra of P-GCN3 and GCN3

3. SEM image of P-GCN1, TEM and HRTEM images of GCN1

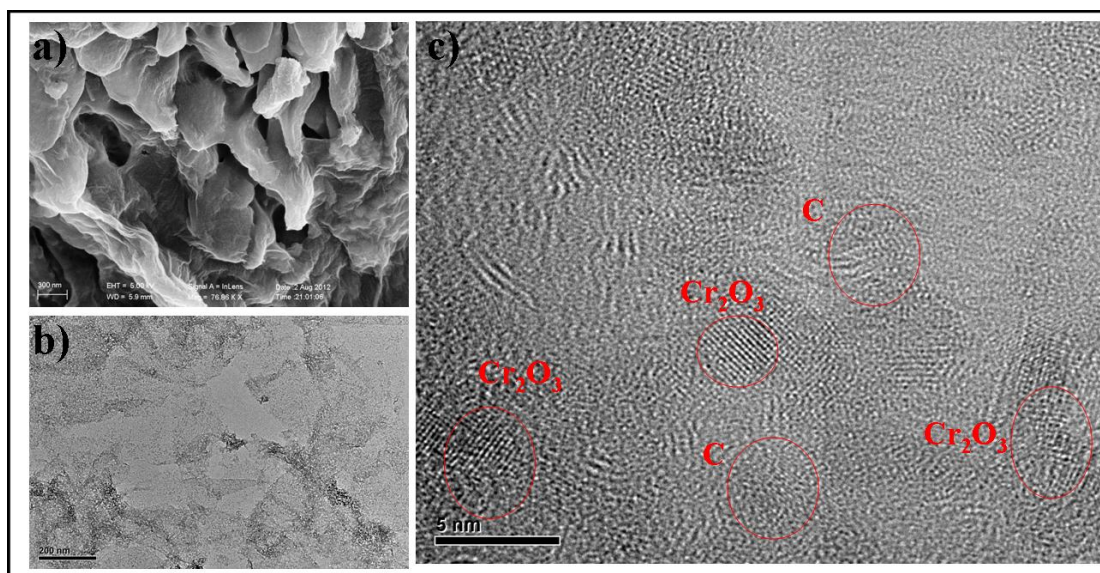


Figure SI 2. a). SEM image of P-GCN1; b). TEM and HRTEM images of GCN1

4. SAED and EDS of GCN3

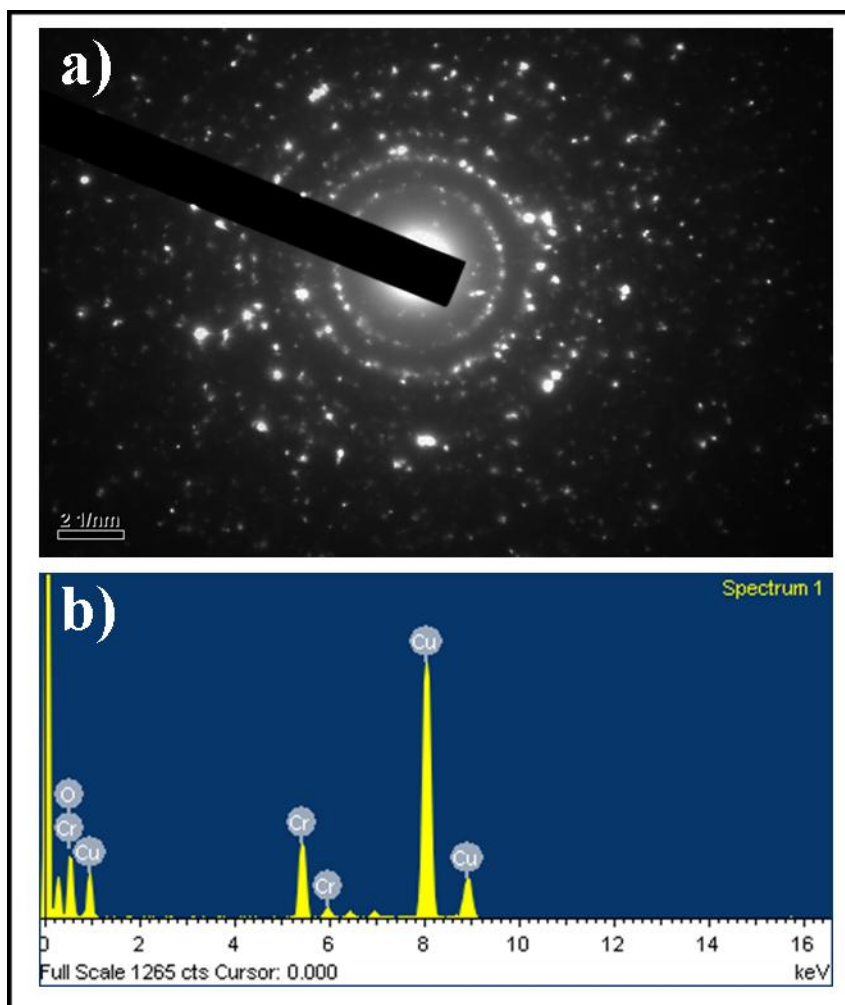


Figure SI 3. a). SAED of GCN3; b). EDS of GCN3.

5. Determination of the component ratios of GCN1, GCN3 and CN by TGA in air

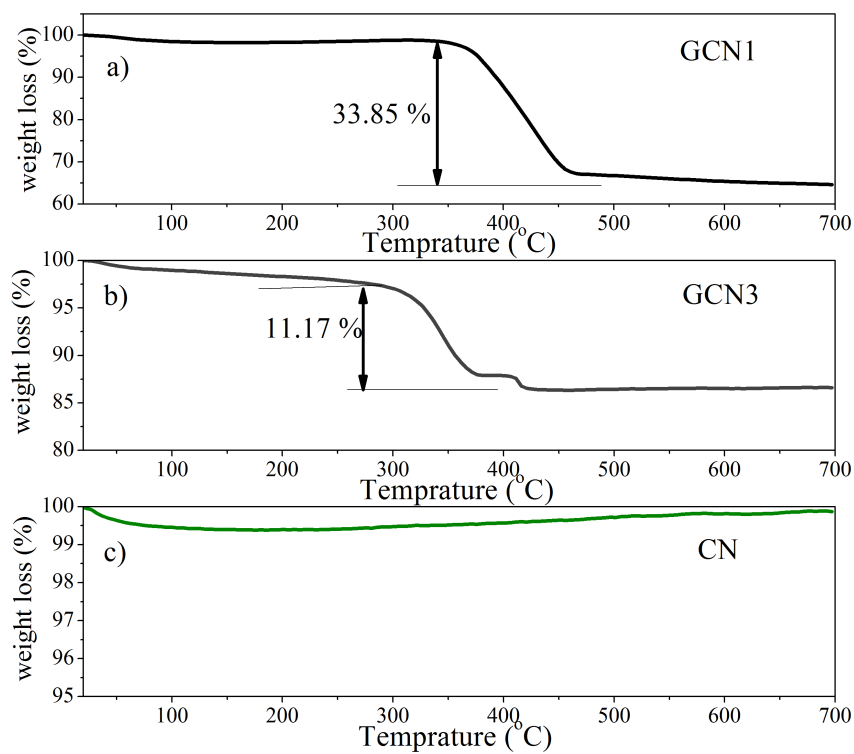


Figure SI4. a) TGA of GCN1; b) TGA of GCN3; c) TGA of CN.

6. Raman spectrum of P-CN

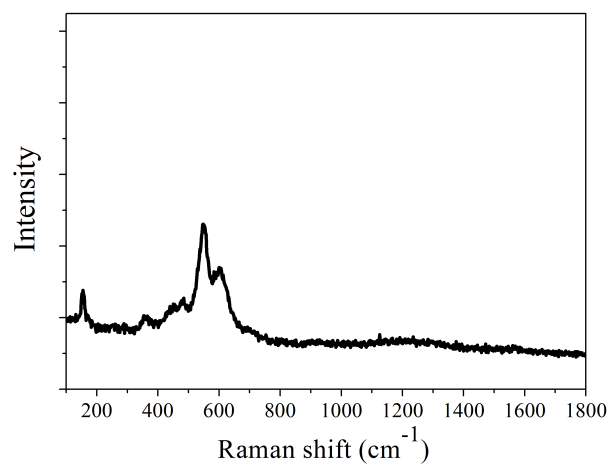


Figure. SI5. Raman spectrum of P-CN

7. Cycling performance of GCN3 and GCN1, and electrochemical impedance spectroscopy of CN, GCN3 and GCN1.

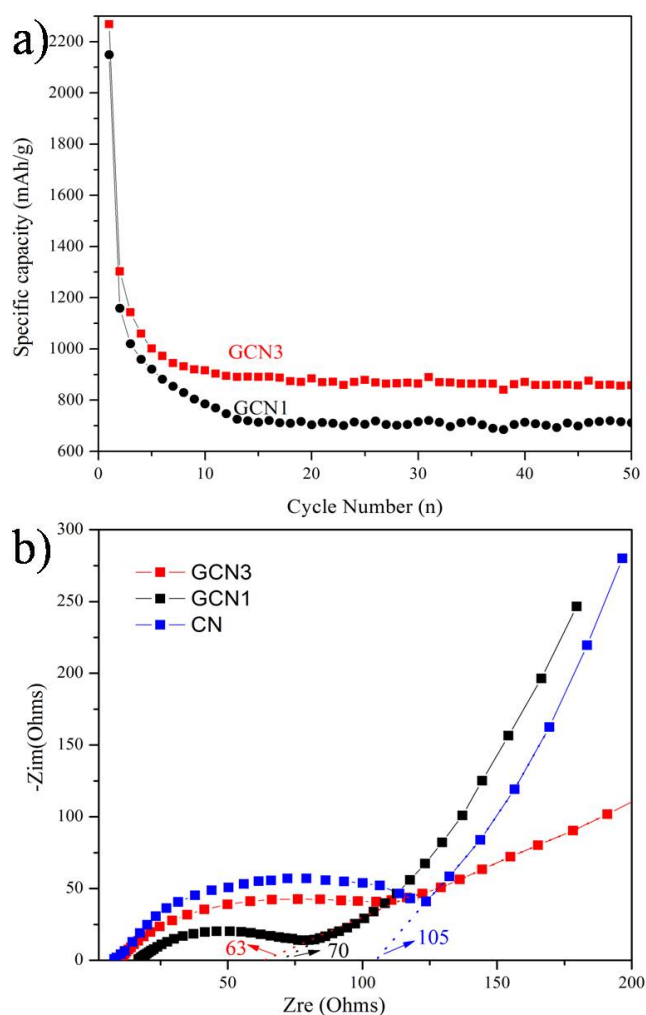


Figure SI6. a) Cycling performance of GCN3 and GCN1 tested up to 50 cycles at a current of 200 mA/g ; b) The Nyquist plots of CN, GCN3 and GCN1 tested without pre-cycling testing. Frequency between 0.1 Hz to 100 KHz at room temperature.