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Fe_2O_3 Nanocrystal Anchored on Graphene Nanosheets as Anode Material for Low-Cost Sodium-Ion Batteries

Zelang Jian,[a] Bin Zhao,[b] Pan Liu,[c] Fujun Li,[a] Mingbo Zheng,[b]* Mingwei Chen,[c] Yi Shi[b] and Haoshen Zhou[a,b]*

[a] *Energy Technology Research Institute, National Institute of Advanced Industrial Science and Technology, (AIST), Umezono 1-1-1, Tsukuba, 305-8568, Japan. Tel: 81-29-861-5795; E-mail: hs.zhou@aist.go.jp*
[b] *Nanjing National Laboratory of Microstructures, School of Electronic Science and Engineering, & School of Modern Engineering and Applied Science, Nanjing University, Nanjing 210093, China.* Tel: 86-25-83621220; *E-mail: zhengmingbo@nju.edu.cn*
[c] *WPI Advanced Institute for Materials Research,Tohoku University, Sendai, 980-8577, Japan*

Experimental

Graphite oxide (GO) was prepared from natural graphite powders (universal grade, 99.985%) via a modified Hummers method. Dried GO was thermally exfoliated at 300 ºC for 3 min in air. The sample was then treated at 900 °C for 3 h in Ar at a heating rate of 2 ºC/min. The obtained product was denoted as GNS.

$Fe(NO_3)_3 \cdot 9H_2O$ was first dissolved in ethanol, into which GNS was added. And then, the mixture was sonicated for 10 min. After ethanol was evaporated, the black sediment was collected and treated at 40 °C for 24 h in a blast drying oven. The dried $Fe(NO_3)_3 \cdot 9H_2O$/GNS composite was subsequently treated at 200 °C for 10 h. The obtained product was denoted as Fe_2O_3@GNS.

Characterization and measurements

Powder X-ray diffraction (XRD) was performed on a Bruker D8 Advanced diffractometer with Cu Kα (λ = 1.5406 Å) radiation. Scaning electron microscope (SEM) and scanning transmission electron microscope (STEM) images were obtained on Hitachi S4800 and JEOL JEM-2100F, respectively. TG curve of the Fe_2O_3@GNS sample was obtained using a Diamond TG thermoanalyzer. Raman spectra were obtained on a Micro Raman spectrophotometer (Ventuno21, JASCO). N_2 adsorption-desorption analysis was performed using a Micromeritics ASAP 2010 instrument. The specific surface area was calculated by the Brunauer–Emmett–Teller (BET) method using the adsorption branch. The Mössbauer spectra were measured in a transmission configuration and in constant acceleration mode at room temperature with a radioactive source of ^{57}Co in Rh matrix.

The electrodes were prepared with active materials and poly(vinyl difluoride) at a weight ratio of 80: 20. The slurry was cast on pure Cu foil and dried at 100 °C in vacuum for 10 h. The coin cells CR2032 were assembled with pure sodium foil as counter electrode, a glass fiber as separator, and 1 M $NaPF_6$ EC: DMC (1:1) as electrolyte in an argon filled glove box. The electrochemical measurements were performed on Hokudo Denko Charge/Discharge instruments at 25 °C. The Na storage tests for the naked Fe_2O_3 + GNS and Fe_2O_3@GNS samples were performed at a voltage range of 0.05–3 V. The capacity was based on the Fe_2O_3 mass. Cyclic voltammetry (CV) was performed on a Solartron 1253B Frequency Response Analyzer.

Acknowledgements:

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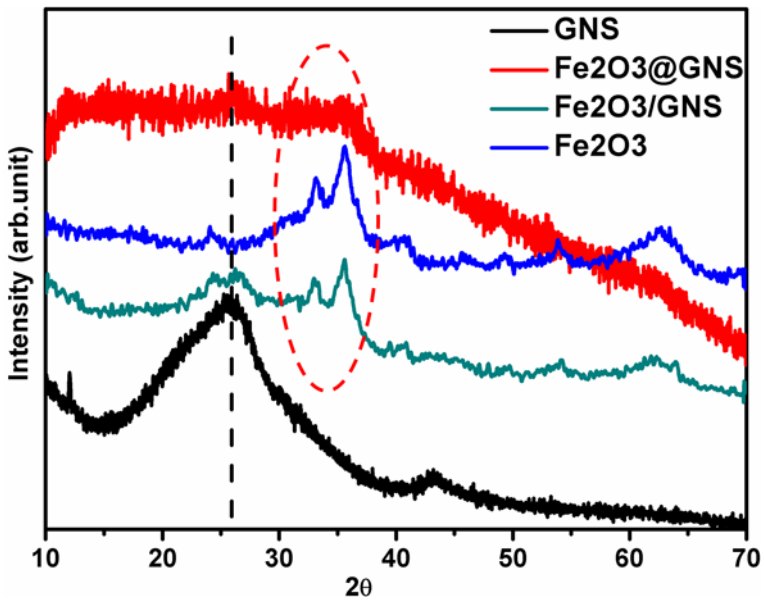

Fig. S1 XRD patterns of GNS, Fe_2O_3, Fe_2O_3/GNS and Fe_2O_3@GNS.

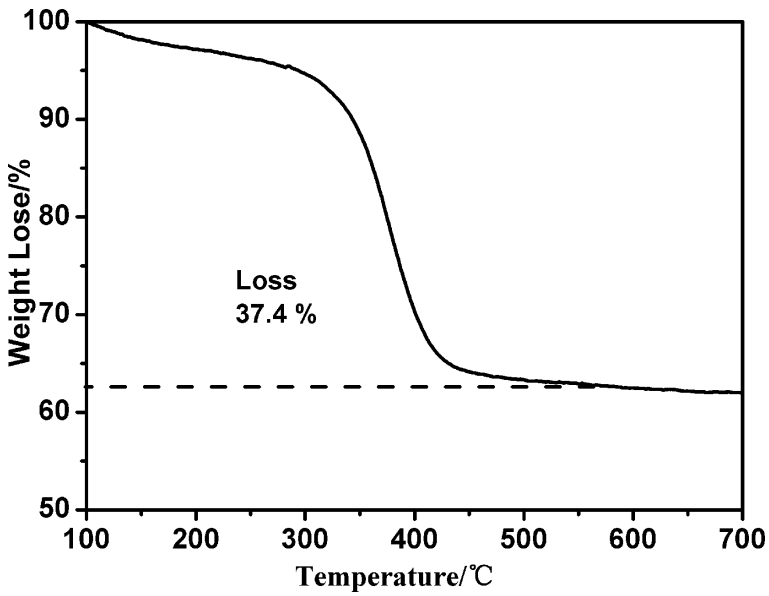

Fig. S2 TG curve of the Fe_2O_3@GNS sample.

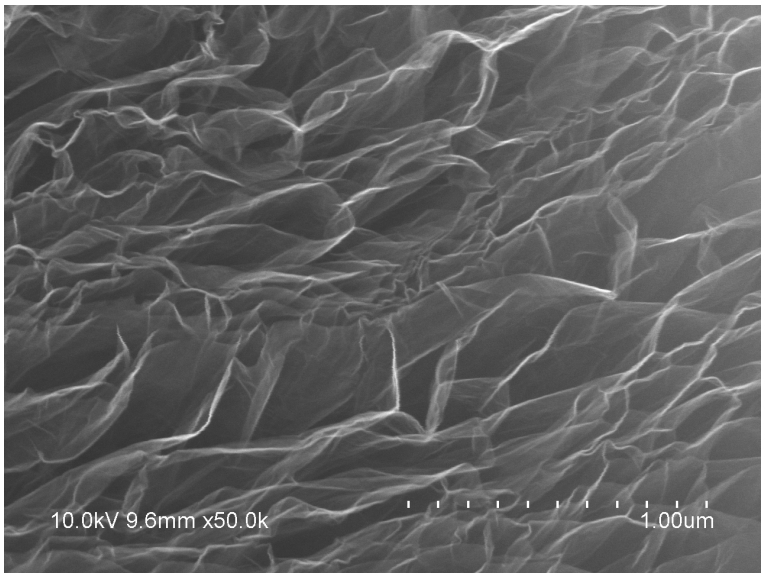

Fig. S3 SEM image of GNS.

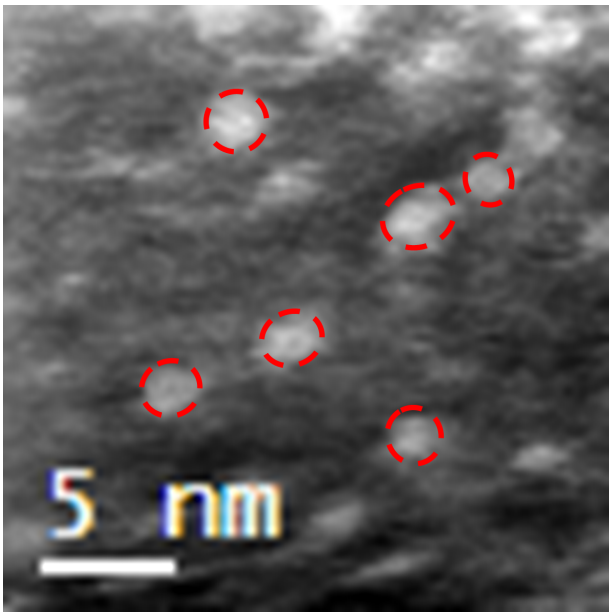

Fig. S4 High magnification STEM image of Fe_2O_3@GNS.

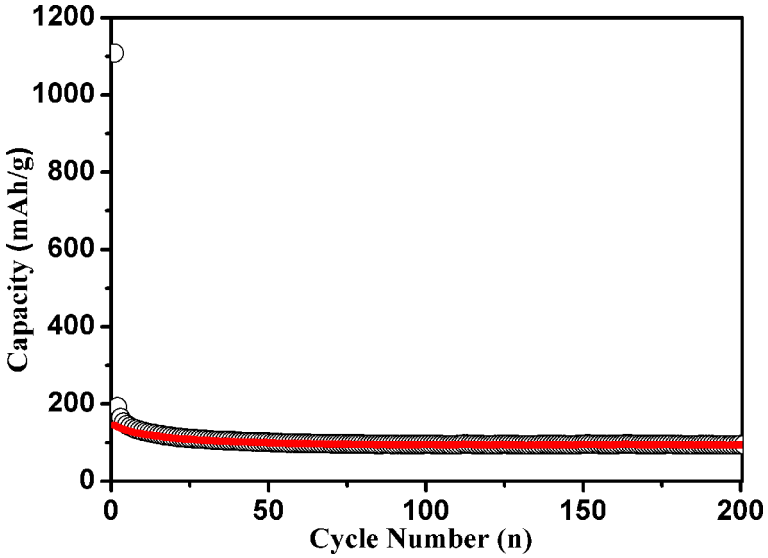

Fig. S5 Cycling performance of pure GNS at a current of 100 mA/g.