Supporting Information

Flexible paper electrode constructed of Zn_2GeO_4 nanofibers anchored with amorphous carbon for advanced lithium ion batteries

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Experimental Section

Materials: All the materials were purchased from Beijing Chemical Reagent Factory without further purification. Polyacrylic acid (PAA, M.W~450,000), GeO_2 (99.99%, metal basis, 200 mesh), $Zn(CH_3COOH)_2 \cdot 2H_2O$ (99.99%, metal basis), citric acid monohydrate (A.R).

Preparation of ZGO/C-P: The starting material (Zn_2GeO_4 nanorod) was prepared according to Perng *et.al*'s work using a simple reflux method.[1] 200 mg prepared Zn_2GeO_4 nanorod was added into a 7.5 wt % aqueous PAA solution, and the mixture was stirred for 1 h at room temperature, the citric acid was added slowly until the solution becomes clear and transparent. Then, the resulting viscous solution was loaded into a plastic syringe equipped with a flat stainless steel needle of 0.9 mm in diameter and electrospun using an electrospinning system. Finally, the obtained Zn_2GeO_4/PAA fibers was carbonized by calcination at 700°C for 5 h under N_2 atmosphere to gain the ZGO/C-P production.

Material characterization: The structure of the obtained ZGO/C-P was characterized by X-ray diffraction (XRD, Rigaku P/max 2200VPC) using Cu Kα radiation. X-ray photoelectron spectra (XPS) were performed with Al Kα radiation and energy step size of 0.1 eV. Transmission electron microscope (TEM, JEM-2010F, 200 kV) and scanning electron microscope (SEM, JEOL JSM-6700F Field Emission) were used to study the morphology of the products.

Electrochemical measurement: Pure lithium foil was used as the counter electrode and a 1.0 M $LiPF_6$ in 1:1 v/v ethylene carbonate (EC)/dimethyl carbonate (DMC) as the electrolyte. The 2032 coin cells were assembled in an Ar-filled glovebox with the concentrations of moisture and oxygen all below 0.1 ppm. Galvanostatic cycling measurements were made using a Land battery test system

(LAND CT2001A) from 0.005 to 2.9 V. ZGO/C-P was directly used as the working electrodes. Cyclic voltammetry (CV) curves were taken using a VersaSTAT 3 (Princeton Applied Research) over the potential range of 0.005-2.9 V at a scan rate of 0.1 mV/s.

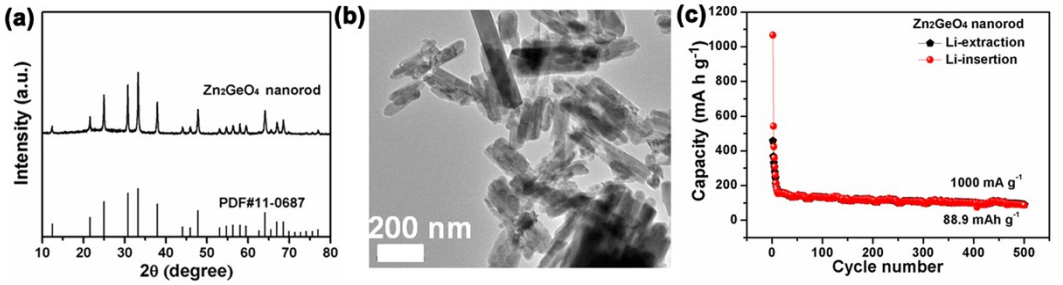

Figure S1. (a) XRD pattern, (b) TEM image and (c) cycle performance of the starting material: the prepared Zn_2GeO_4 nanorod.

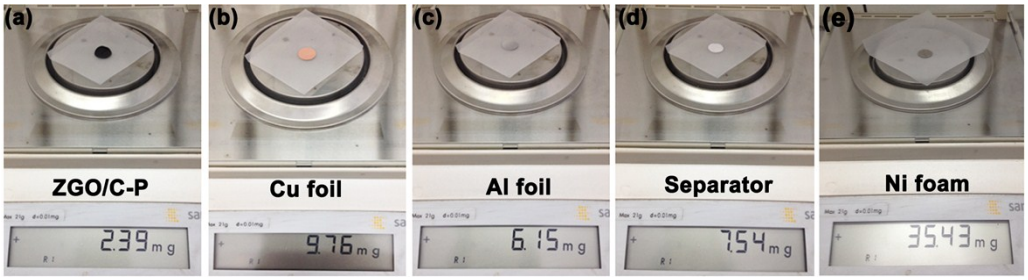

Figure S2. Weight comparison of (a) ZGO/C-P, (b) Cu foil, (c) Al foil, (d) separator, and (e) Ni foam at the same large area of 1.44 cm^2.

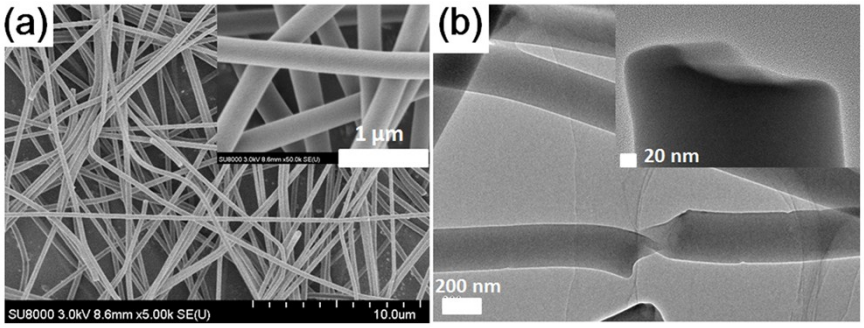

Figure S3. (a) SEM and (b) TEM images of the ZGO in CA-PAA precursor.

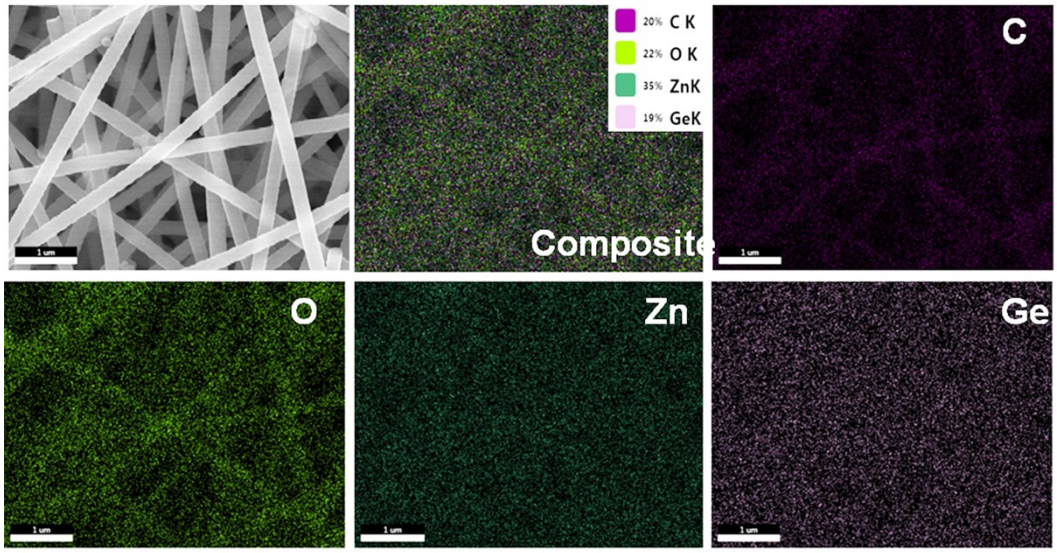

Figure S4. The EDS maps of ZGO/C-P composite samples, an even distribution of carbon, oxygen, zinc, and germanium..

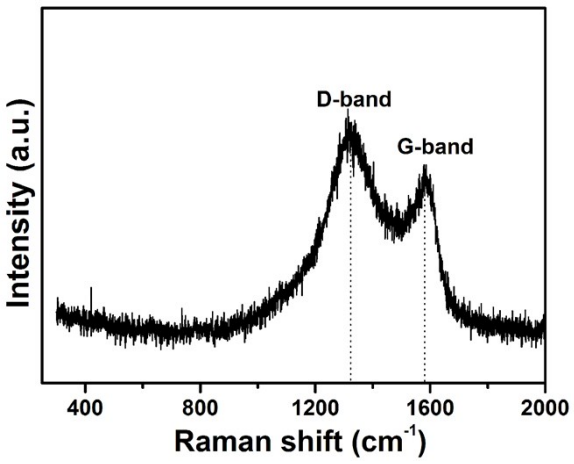

Figure S5. Raman spectrum of the ZGO/C-P composite.

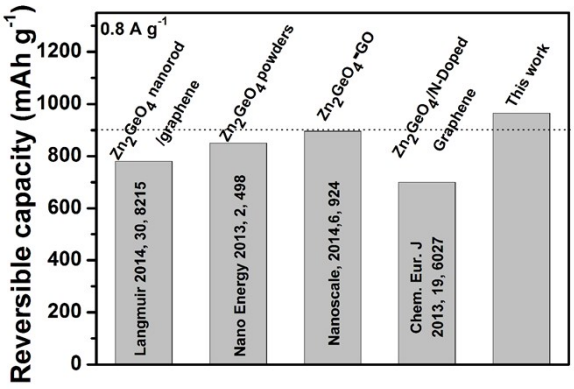

Figure S6. Comparison of the electrochemical performance with the reported results.

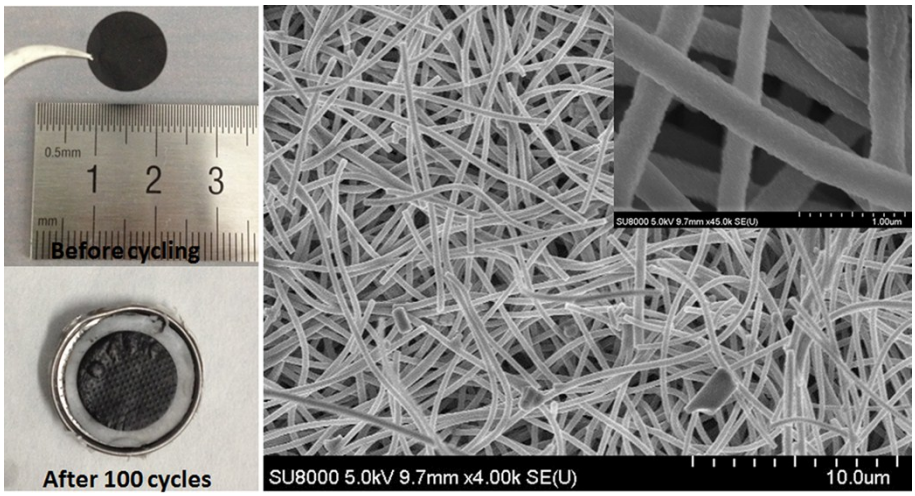

Figure S7. SEM image of ZGO/C-P after 100 cycles at a current density of 1 A g^{-1}.

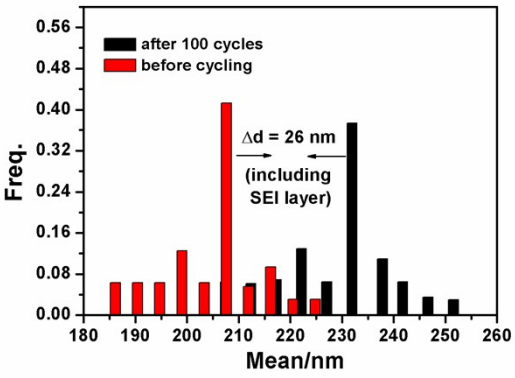

Figure S8. Diameter size distributions of ZGO/C-P before and after running 100 cycles.

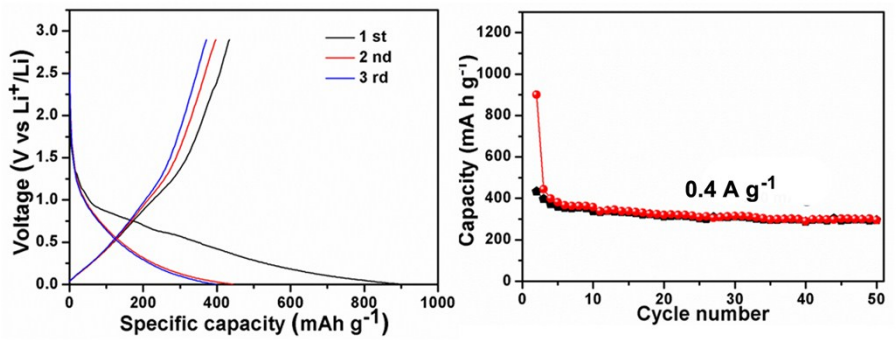

Figure S9. (a) Galvanostatic charge–discharge profiles (b) cyclic performance of C_{PAA} at 0.4 A g^{-1}.

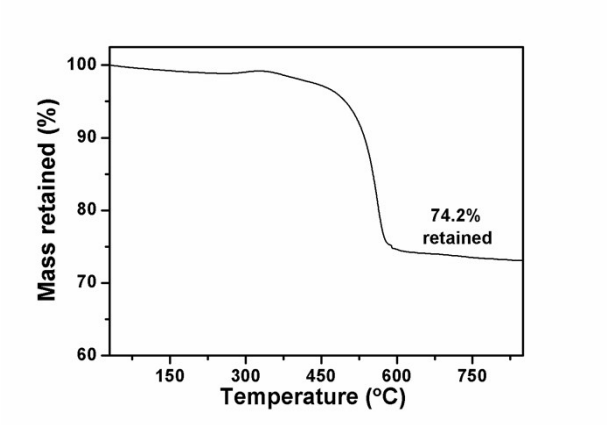

Figure S10. TGA curve of ZGO/C-P carried out in air atmosphere.

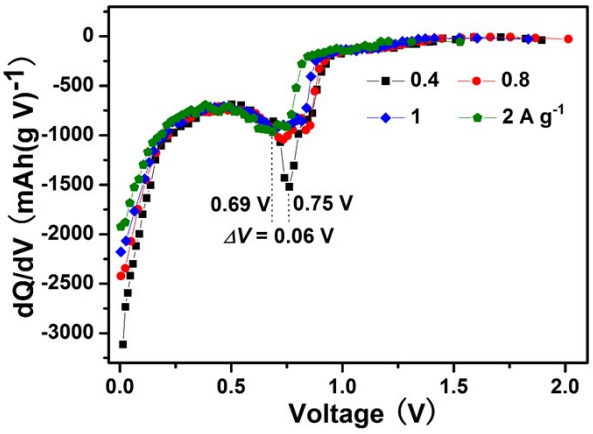

Figure S11. The dQ/dV differential curves of the discharge profiles of ZGO/C-P under different current densities.

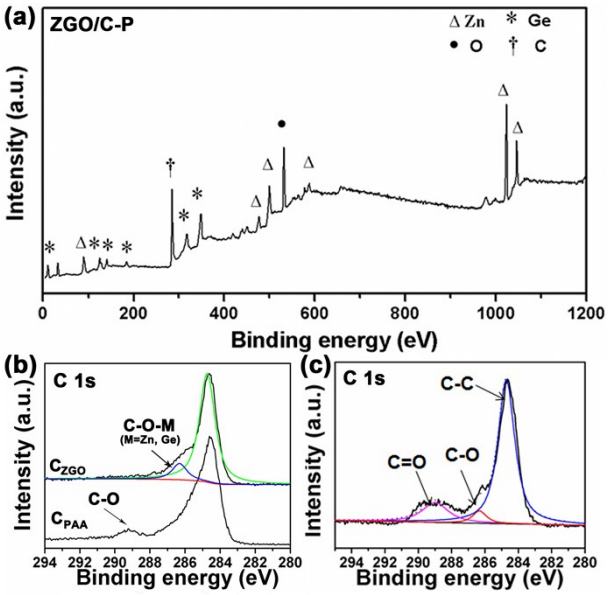

Figure S12. (a) A survey XPS and C 1s peaks of ZGO/C-P. (b) High-resolution XPS spectra of the C 1s peaks for C_{PAA} and C_{ZGO} before cycling. (c) High-resolution XPS spectrum of the C 1s peaks for C_{ZGO} after 100 cycles.

References

[1] M.-Y. Tsai, S.-H. Huang, T.-P. Perng, *J. Lumin.* 2013, **136**, 322-327.