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Electronic Supporting Information

Preparation and Application of Flower-Rods-Like Bi_2S_3/Co_3O_4/rGO/Nickel Foam Supercapacitor Electrode

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1 Experiment

Preparation of BCGN electrode and comparison samples

NF (20 mm × 10 mm × 1 mm) was continuously washed and sonicated for 0.5 h with 3 mM HCl aqueous solution, acetone, ethanol and deionized water, respectively.

Preparation of Bi_2S_3/Co_3O_4 (BC): Firstly, add 1 mM bismuth nitrate, 1 mM cobalt acetate tetrahydrate, 1.5 mM sodium sulfite and 1 mM urea to in 10 ml of distilled water and stir with a magnetic stirrer for 30 min to get the mixed solution. Next, transfer the mixed solution to a 25 ml autoclave lined with polytetrafluoroethylene and heat it at 120 ℃ for 12 hours. After the reaction completed, the autoclave was cooling to room temperature and washing the solids in the solution repeatedly with DI water and ethanol then dried it at 90 ℃ for 2 hours. Finally, the solid was annealed in air at 350 ℃ for 2 hours.

Preparation of rGO/NF (GN): Firstly, 10 ml 1 mg·ml^{-1} GO suspension was ultrasonically treated for 0.5 h. Next, transfer the mixed solution and clean NF to a 25 ml autoclave lined with polytetrafluoroethylene and heat it at 120 ℃ for 12 hours. After the reaction is completed, open the autoclave to room temperature to cool, take out the NF electrode inside, wash it with deionized water and ethanol, and dry it in an oven at 90 ℃ for 2 h. Finally, the electrode was annealed in air at 350 ℃ for 2 hours.

Preparation of Bi_2S_3/rGO/NF (BGN): Firstly, 10 ml 1 mg·ml^{-1} GO suspension was ultrasonically treated for 0.5 h. Add 1 mM bismuth nitrate, 1.5 mM sodium sulfite and 1 mM urea to the suspension and stir with a magnetic stirrer for 30 min to get the mixed solution. Next, transfer the mixed solution and clean NF to a 25 ml autoclave lined with polytetrafluoroethylene and heat it at 120 ℃ for 12 hours. After the reaction is completed, open the autoclave to room temperature to cool, take out the NF electrode inside, wash it with deionized water and ethanol, and dry it in an oven at 90 ℃ for 2 h. Finally, the electrode was annealed in air at 350 ℃ for 2 hours.

Preparation of Co_3O_4/rGO/NF (CGN): Firstly, 10 ml 1 mg·ml^{-1} GO suspension was ultrasonically treated for 0.5 h. Add 1 mM cobalt acetate tetrahydrate and 1 mM urea to the suspension and stir with a magnetic stirrer for 30 min to get the mixed solution. Next, transfer the mixed solution and clean NF to a 25 ml autoclave lined with polytetrafluoroethylene and heat it at 120 ℃ for 12 hours. After the reaction is completed, open the autoclave to room temperature to cool, take out the NF electrode inside, wash it with deionized water and ethanol, and dry it in an oven at 90 ℃ for 2 h. Finally, the electrode was annealed in air at 350 ℃ for 2 hours.

Material characterization

The structure and phase characterization were determined by a Bruker D8 Advance X-ray powder diffractometer (XRD, Germany) using Cu Ka radiation (40 kV, 40 mA, l = 0.15418 nm) was performed over the 2θ range 10-80 °and in a continuous scan mode with a scan speed of 5 °min-

1. Surface functional group spectroscopy was examined by X-ray photoelectron (XPS, Model PHI 5300, Physical Electronics, USA). The surface morphology and microstructure of the material was characterized by a field emission scanning electron microscope (SEM, S-4800, Hitachi, Japan) equipped with an Energy Dispersive Spectrometer (EDS), JEM-2010 transmission electron microscope (TEM) and FEI Tecnal G2 F30 high resolution transmission electron microscope (HRTEM). Raman spectroscopy was performed using a Renishaw In Via confocal Raman spectrometer with a Leica DMLM microscope and with an argon ion laser (wavelength 514.5 nm, model Stellar-REN, Modu-Laser) as the excitation source. Nitrogen adsorption experiment was conducted by Tri Star II3020 of micron instruments at room temperature, and the specific surface area of the sample was obtained by analyzing its adsorption isotherm curve by Brunor - Emmett - Tler (BET).

3. Results and discussion

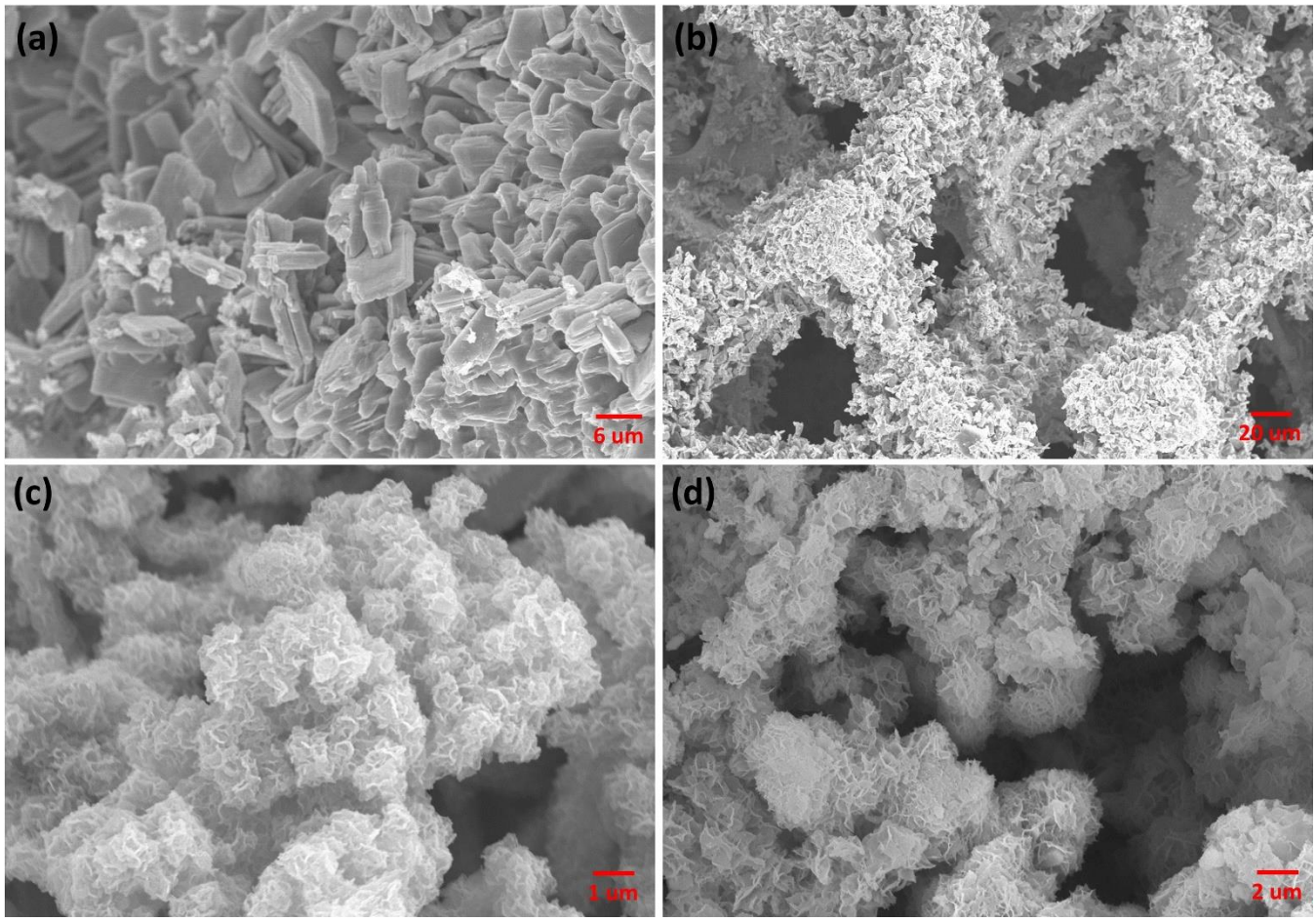
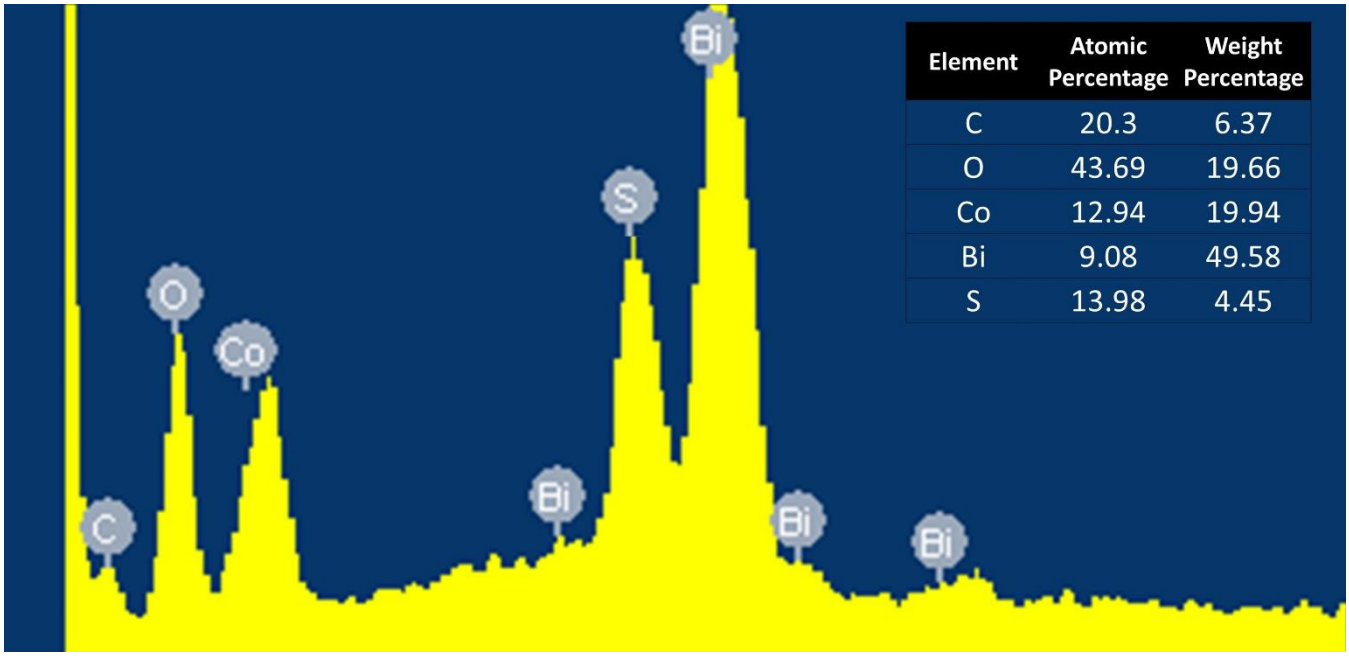


Fig. S1 SEM images of the (a, b) BGN (c, d) CGN.



Element	Atomic Percentage	Weight Percentage
C	20.3	6.37
O	43.69	19.66
Co	12.94	19.94
Bi	9.08	49.58
S	13.98	4.45

Fig. S2 (a) SEM images and (b) EDS elemental mapping images of BCG.

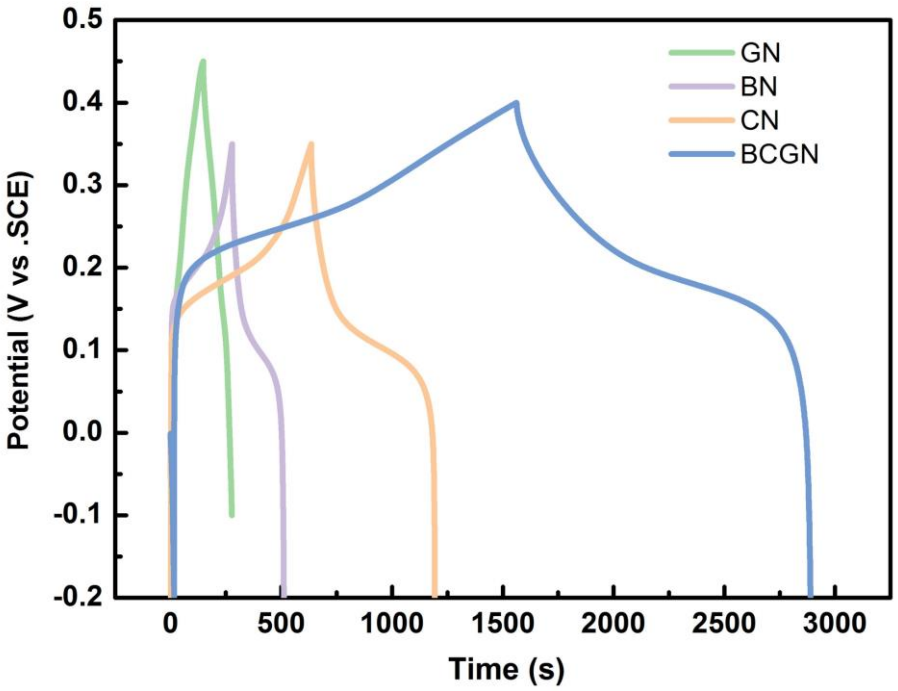


Fig. S3 GCD curve of rGO/NF, Bi_2S_3/NF, Co_3O_4/NF and BCGN electrodes at a current density of 1 A g^{-1}.

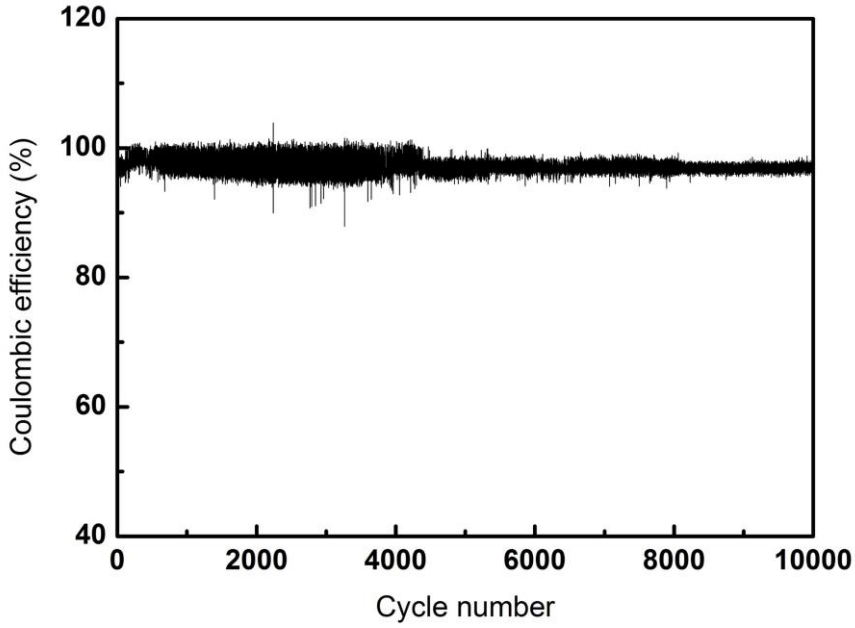


Fig. S4 The coulombic efficiency diagram of BCGN//AC asymmetric supercapacitor cycle charging and discharging 10,000 times at a current density of 10 A g^{-1}.

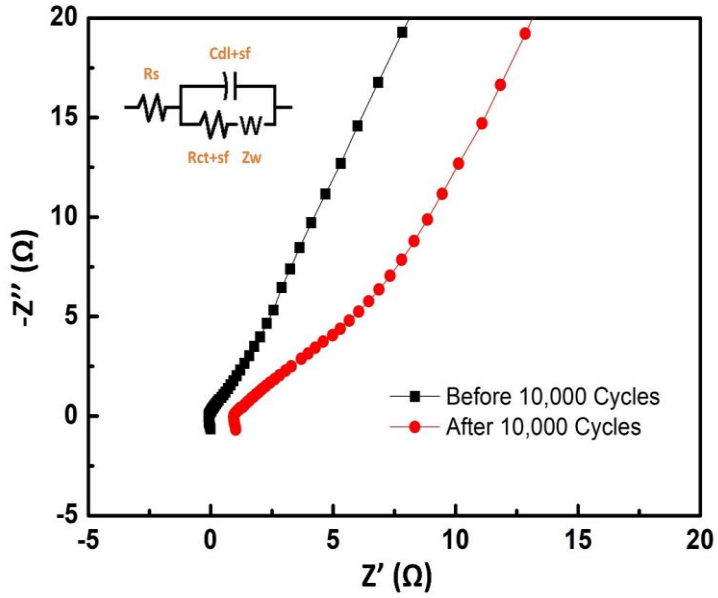


Fig. S5 Nyquist comparison chart before and after the BCGN electrode cycle test.

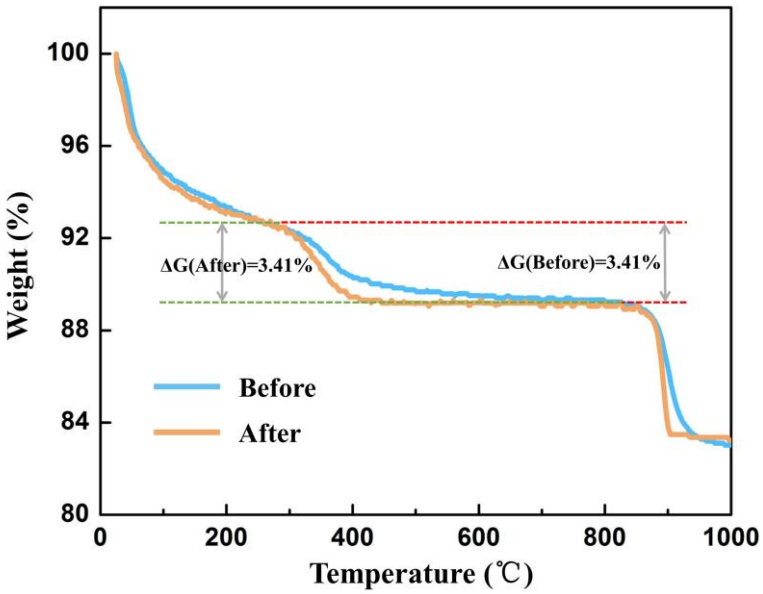


Fig. S6 The thermogravimetric comparison chart of active materials before and after the cycle test.