

## Supporting information

### Preparation of pig bone derived graphite

The dried pig bone (purchased from market in Beijing) particles were pre-carbonized in a tubular furnace under  $N_2$  circumstance at 450 °C. Then the pre-carbonized bone particles were mixed with KOH agent and carbonized at 2.5 °C  $min^{-1}$  to 850 °C and hold for 1 h. The obtained product was washed in diluted  $HNO_3$ , rinsed with distilled water, and dried at 110 °C for 12 h. The final product was carried out at 2800 °C in a graphite electrical furnace for 1 h under argon flow. The heating rates were 25 °C  $min^{-1}$  from room temperature to 1000 °C, 20 °C  $min^{-1}$  in the range 1000-2000 °C and 10 °C  $min^{-1}$  from 2000 °C to 2800 °C.

### Preparation of anode

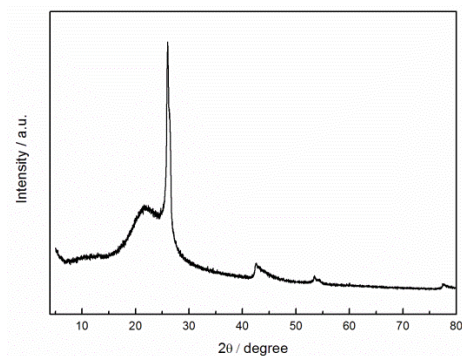
The anodes were mixed with the as-prepared graphite, acetylene black (Jinpu. Corp., China), and gelatin (160 Bloom g, type B) in a weight ratio of 80:10:10. Negative electrodes were produced by coating the slurry on copper foil and drying at 60 °C under vacuum (vacuum degree: -0.1 Mpa) for 12 h.

### Materials Characterization

Charged cells were disassembled and the copper current collectors were removed. Then the obtained powder was fully rinsed with DMC in the glove box. The morphologies and microstructures of the composites were characterized using a scanning electron microscope (SEM, HITACHI S-4700) operated at 20 kV. High-resolution transmission electron microscopy (HRTEM, JEOL JEM-2100) and transmission microscopy (TEM, HITACHI H-800) were employed to characterize the microstructure of materials. A Renishaw InVia Reflex Raman system (Renishaw plc., Wotton-under-Edge, UK) was used employing a grating spectrometer with a Peltier-cooled charge-coupled device (CCD) detector, coupled to a confocal microscope. The Raman scattering was excited using an Argon ion laser wavelength of 514 nm. Surface roughness and morphologies of the pig-bone-based graphite were analyzed by Atomic Force Microscopy (AFM, Dimension Icon, Bruker, Germany). Scanning Tunneling Microscope (STM) analysis was carried out on XMU-BY base in ambient condition.

### Electrochemical Measurement

All the anodes were cut into disks with diameter 12 mm to assemble the batteries in an Ar-filled glove box, with ethylene carbonate (EC)/ethylmethyl carbonate (EMC)/ Dimethyl carbonate (DMC) (V/V/V =1/1/1), and 1M lithium hexafluorophosphate (LiPF<sub>6</sub>) as the basic standard electrolyte. The discharge tests were carried out in the voltage range of 0.005-3 V, with a LAND Electronic Co.Ct2001A instrument.



**Figure 1.** Powder XRD pattern of the pig-bone-based graphite