Electronic Supplementary Material (ESI) for ChemComm.

SUPPORTING INFORMATION

A New Aluminium-ion Battery with High Voltage, High Safety and Low Cost

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Experimental Section

All materials and chemicals were purchased commercially and used as received. A sealed Teflon electrolytic tank (Figure S1c) was used for the Al-ion battery. The cathode was fabricated as follows. Round carbon paper with a diameter of 16 mm was firstly fixed by two molybdenum sheets and wire (Figure S1a). Then the above electrode was wrapped by a piece of glass fiber (GF/D) from Whatman to form the cathode for Al-ion battery. Aluminium foil (12 mm × 20 mm) with high purity was used as anode. Before testing, the aluminium foil was washed in an ultrasonic cleaner for 15min. To prepare the electrolyte, $AlCl_3$ was dissolved in 1-ethyl-3-methylimidazolium chloride ([EMIm]Cl) with the molar ratio 1.3:1. This process must be operated in a glovebox full of argon. The Al-ion full battery comprised of cathode, anode, electrolyte and a sealed Teflon electrolytic tank, as shown in Figure S1c. The batteries were assembled in an argon filled glove box and then galvanostatically cycled at different current densities in the voltage range of 0.4–2.35 V using Solartron electrochemical workstation (Solatron 1287/1255B). Due to the low cost and durability of aluminium foil, the specific capacity and current density of the Al-ion battery were calculated based on the mass of the carbon paper.

The crystal structure of the samples was determined by Raman and X-ray photoelectron spectroscopy (XPS, Kratos AXIS Ultra DLD). The morphology was characterized by transmission electron microscopy (TEM, JEOL, JEM-2010) and scanning electron microscopy (SEM, CAMBRIDGE, S-360).

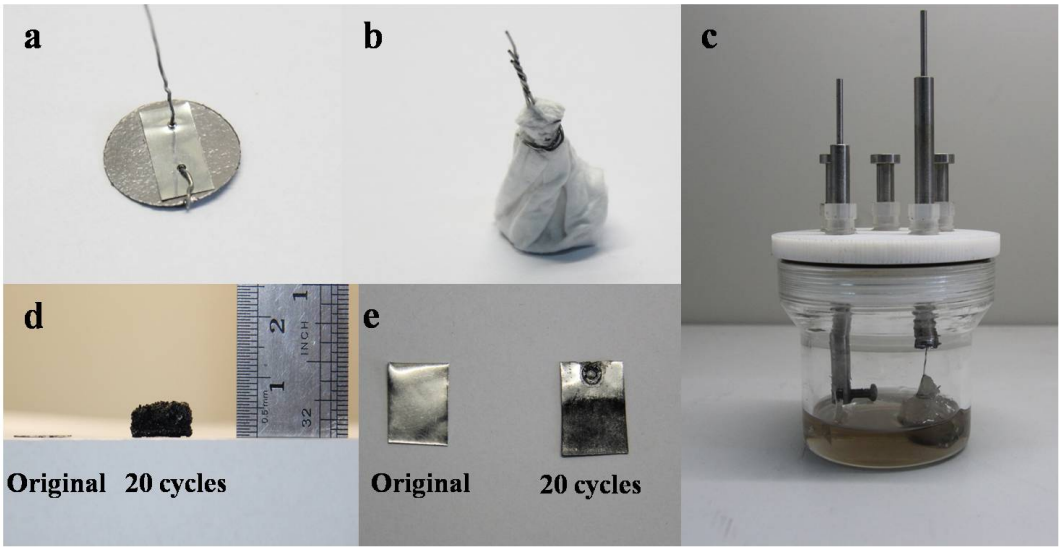

Figure S1 The experimental photographs of (a) cathode: carbon paper fixed by molybdenum sheets and wire, (b) cathode wrapped by glass fiber, (c) sealed teflon electrolytic tank, (d) the comparison of carbon paper: original (left) and discharged for 20 cycles (right) and (e) the comparison of aluminium foil: original (left) and discharged for 20 cycles (right).

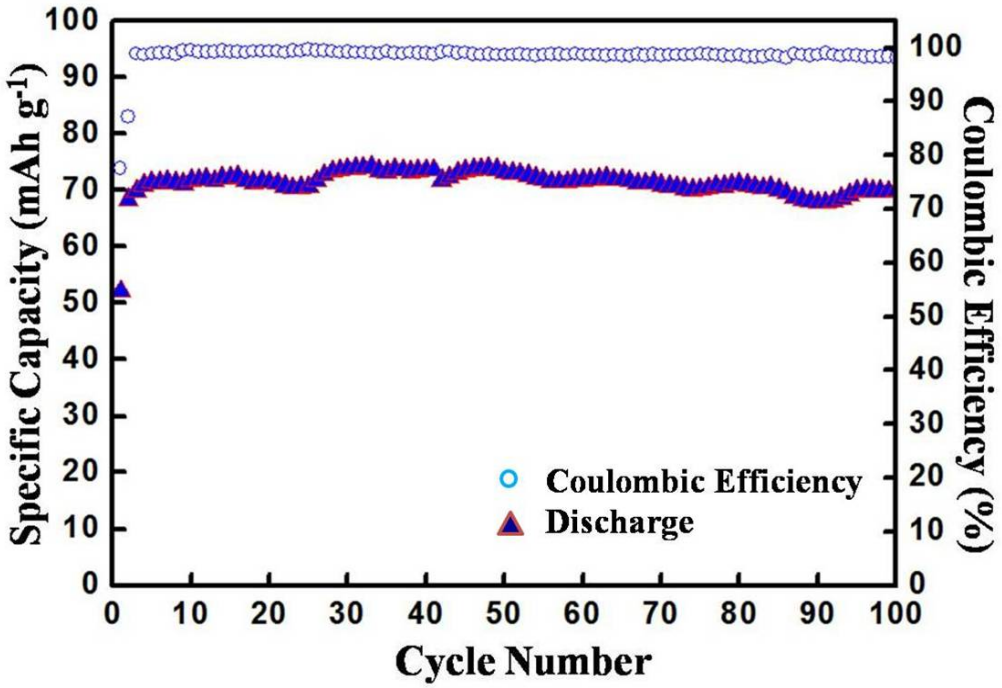

Figure S2 Cycle performance and coulombic efficiency of Al-ion full battery at the current density of 100 mA g^{-1}.

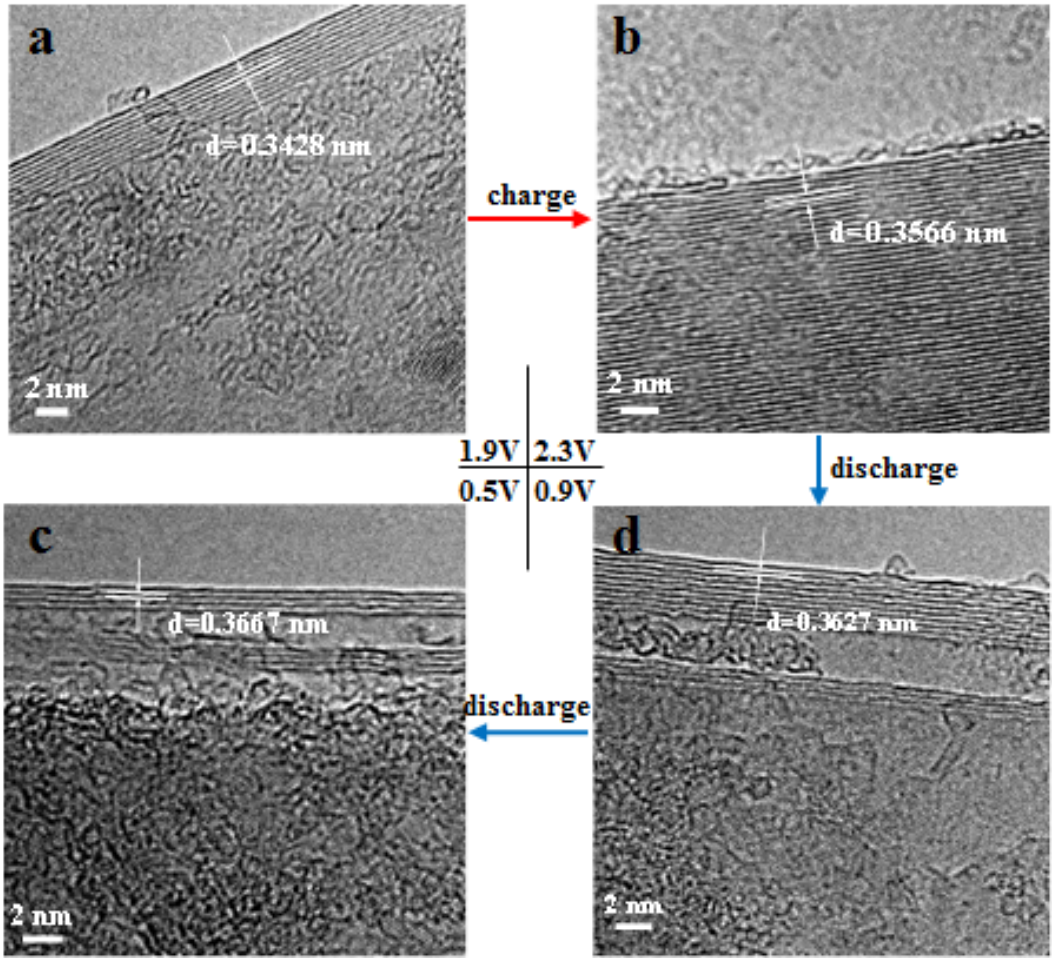

Figure S3 HRTEM images of the products after charge (a,b) and discharge (c,d) processes.

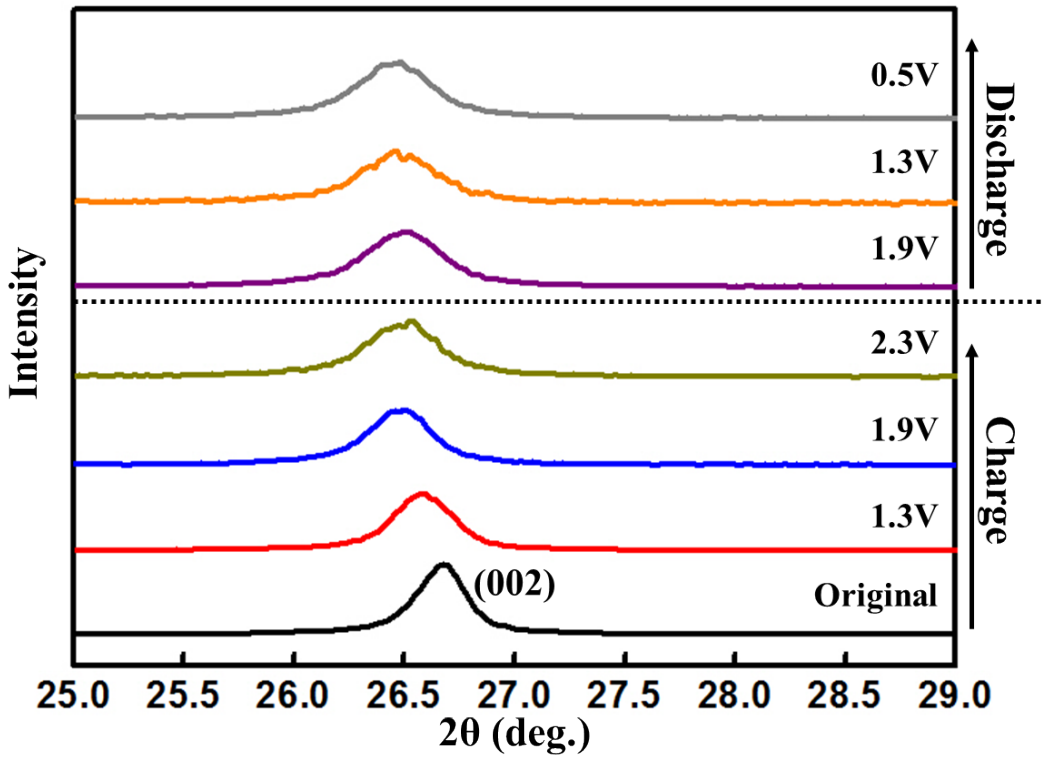

Figure S4 The XRD patterns of the products through a charge-discharge cycle.

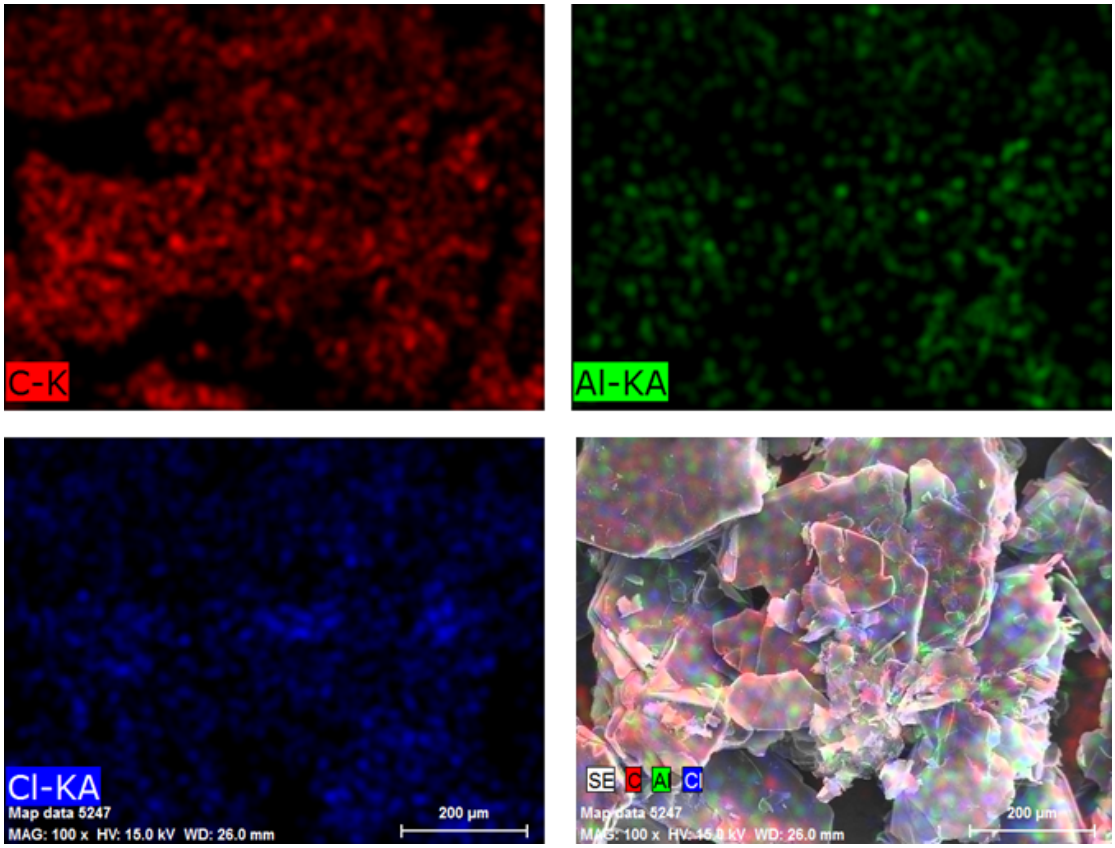

Figure S5 EDS mapping images of the charged cathode.

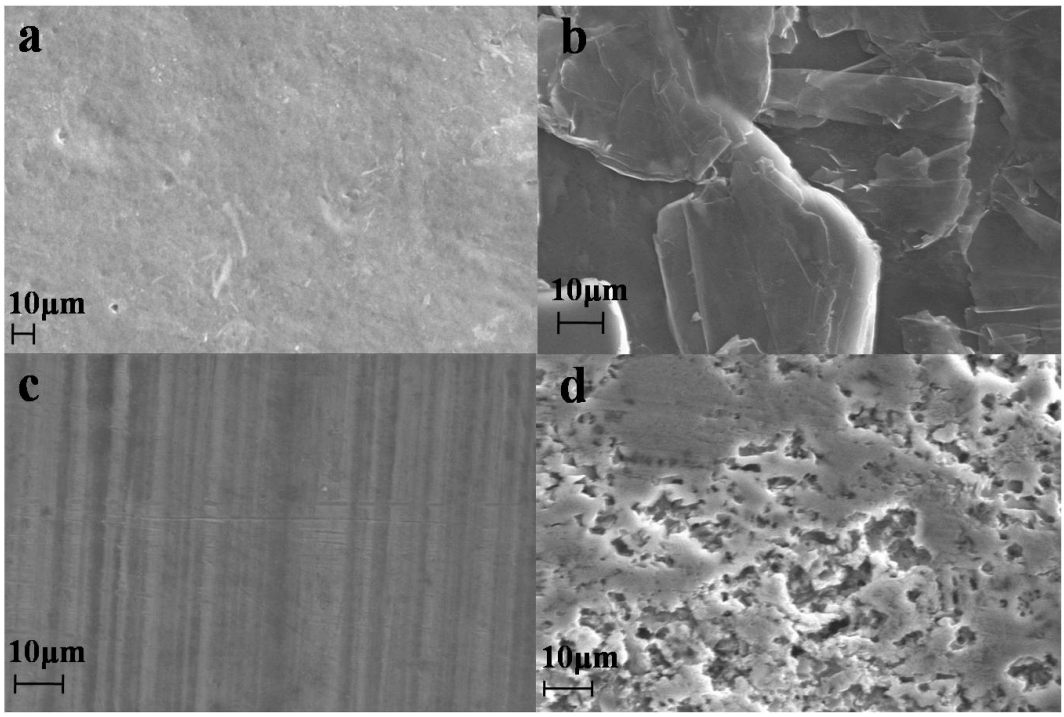

Figure S6 SEM images of (a) original carbon paper, (b) carbon paper after 20 cycles, (c) original aluminium foil and (d) aluminium foil after 20 cycles.