Supporting Information

A New Approach towards Nitrogen-Doped Graphene and Their Hybrids for Ultralong Cycle-Life Lithium Ion Batteries

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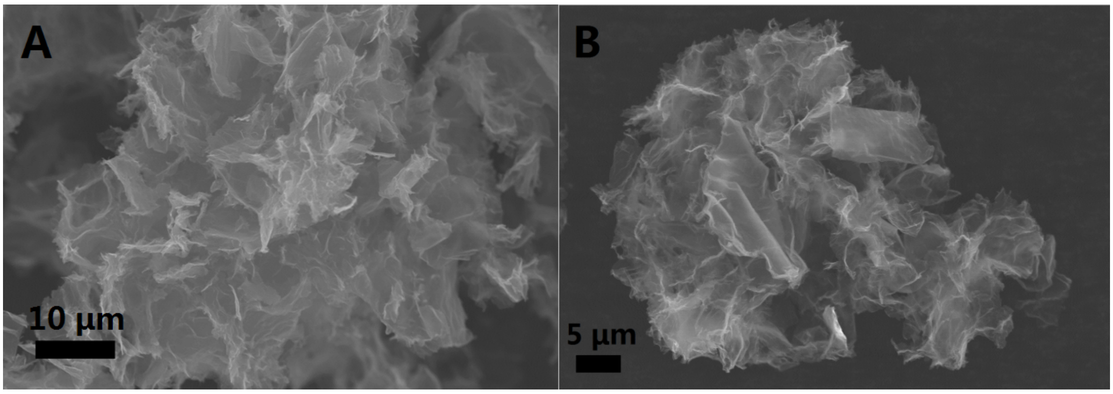

Fig. S1. SEM images of (A) PPy/GO and (B) N-doped graphene.

200 mg PPy/GO nanostructures was annealed in a quartz tube, and about 37.4 mg N-doped graphene was obtained after the carbonization process, which revealed that the mass loading of the PPy was about 81.3%.

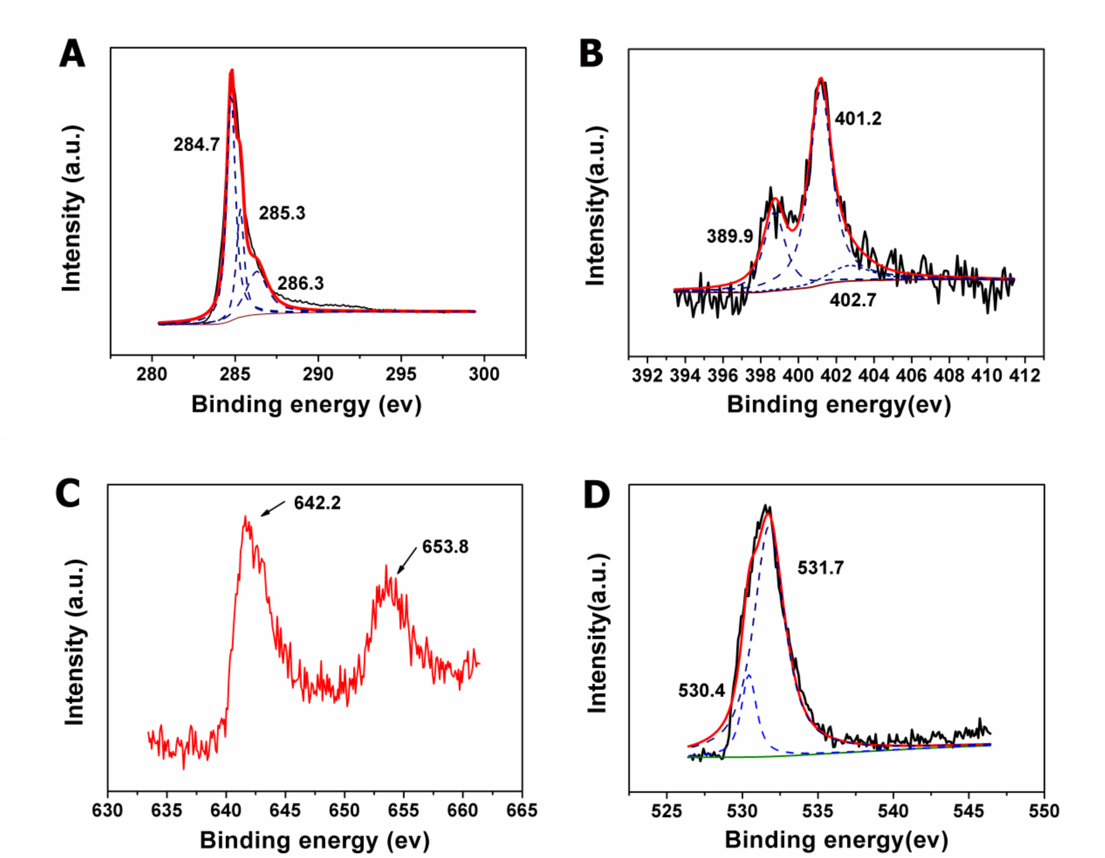

Fig. S2. The high resolution (A) C1s, (B) N1s, (C) Mn2p, and (D) O1s XPS spectra of the MnO_2/NG.

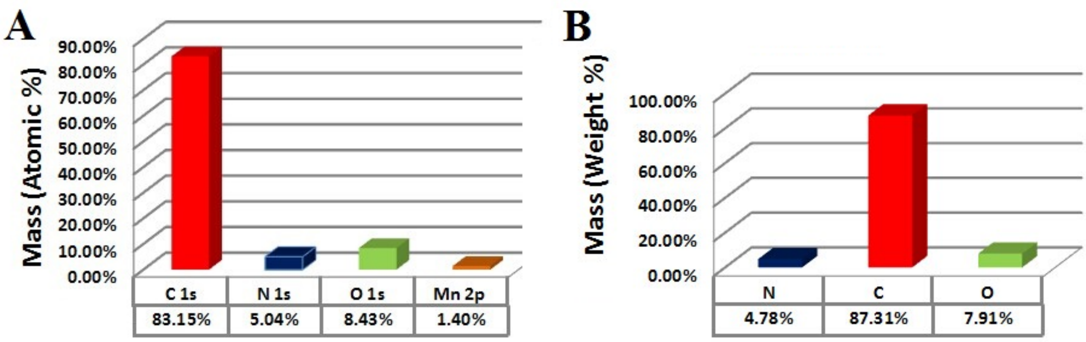

Fig. S3. (A) The element content of the MnO_2/NG by the x-ray photoelectron spectrometer. (B) The element content of the N-doped graphene by the elemental analysis.

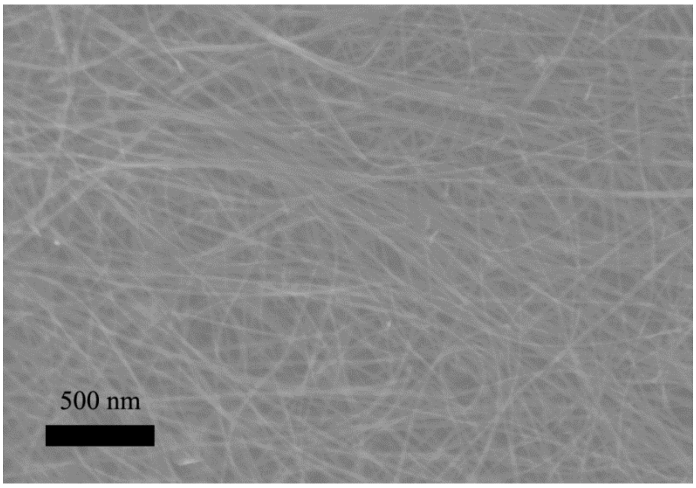

Fig. S4. SEM of pure MnO_2 with similar structures.

Synthesis of pure MnO_2: pure MnO_2 was synthesized by mixing 11 mg $KMnO_4$ in 10 mL of deionized water under adequate stirring, and then maintained for 24 h in teflon-lined stainless steel autoclave at 220 °C.

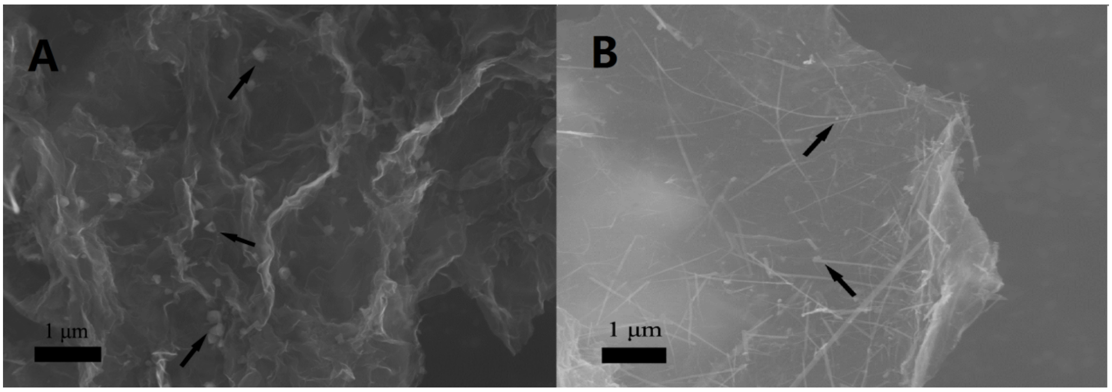

Fig. S5. SEM images of MnO_2 nanorodes grown on the N-doped graphene sheets with hydrothermal reaction for (A) 20 min, and (B) 60 min.

To prove the formation mechanism of MnO_2 nanorods, we try to investigate the morphology of the MnO_2 nanorods with various hydrothermal reaction times. Fig. S5A shows point-like objects grown on the surface of the N-doped graphene after 20 min, which was served as the seeds to grow the MnO_2 nanorods. After reaction 60 min, MnO_2 nanorods with relative small diameters could be observed in Fig. S5B, these phenomena illustrate the formation process of MnO_2 nanorodes on the surface of N-doped graphene.

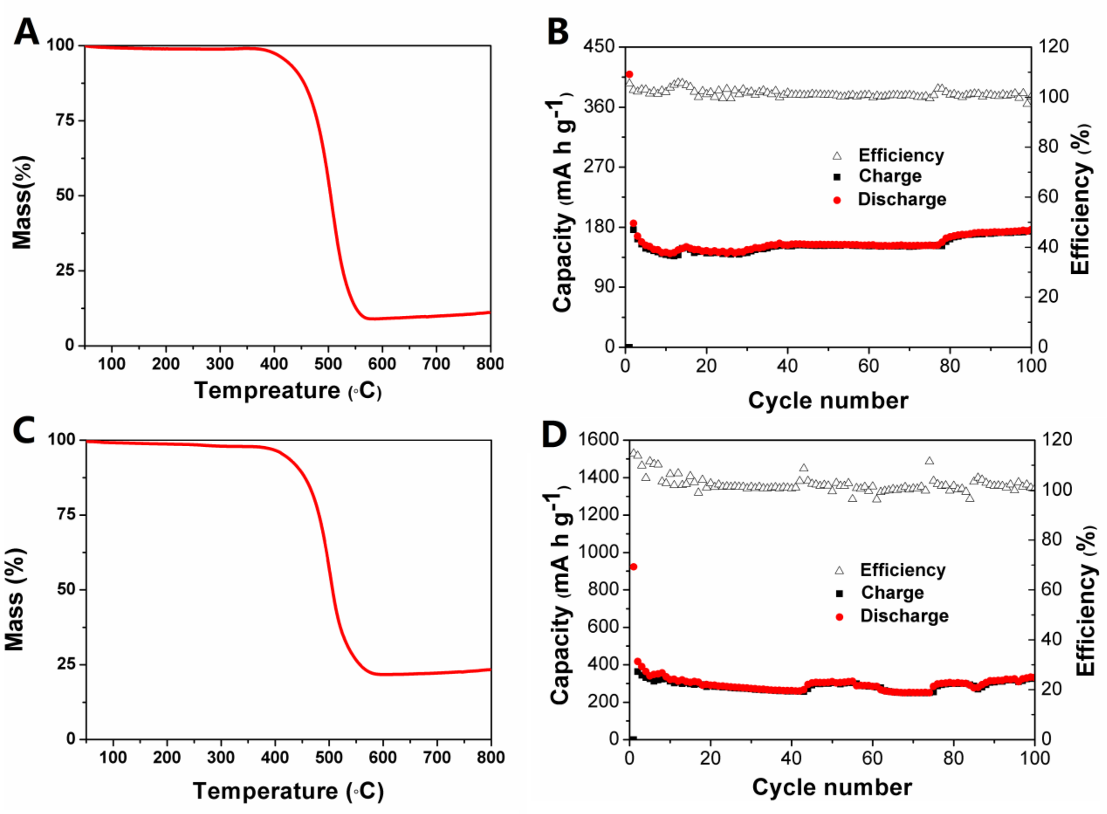

Fig. S6. The TGA between 0 ˚C and 800 ˚C at an increasing rate of 10 ˚C min^{-1}. The contents of the MnO_2 are about the (A) 9.3% and (C) 21.6 %, which delivered a reversible capacity of (B) 136.7 mA h $g^{-1}$and (D) 260 mA h g^{-1} by measuring at 300 mA g^{-1}.

The influence of the MnO_2 content on the electrochemical performance has been considered, and we find that the capacity of hybrids increases with the mass loading of MnO_2 nanorods. We also have tried to further improve the MnO_2 content with excessive precursor ($KMnO_4$), but failed. To confirm the good electrochemical properties of the electrodes, the data of hybrids with different mass loadings of MnO_2 have been presented in the revised supporting information.