Rational design of metal organic frameworks-derived FeS$_2$ hollow nanocages@reduced graphene oxide for K-ion storage

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Figure S1 SEM image of PB@GO.
Figure S2 XRD patterns of PB@GO and Fe@RGO.

In the XRD pattern of Fe@RGO, a broad peak at 26° is attributed to (002) facets of RGO. Other diffraction peaks are assigned to Fe (JCPDS card No. 87-0722) and FeN$_{0.0324}$ (JCPDS card No. 75-2127). The result demonstrates that the RGO and Fe have been reduced after thermal treatment. The formation of FeN$_{0.0324}$ is mainly due to the existence of N element in PB. According to the previous reports, during annealing progress in N$_2$ or Ar atmosphere, transition metal anions will be reduced into pure transition metal, and CN- group linkers will form carbon compounds [1-3]. Furthermore, RGO is also an excellent reducing agent in high temperature, which is helpful for the reduction of Fe ion. Such phenomenon has been reported in other Co-Fe alloys, Ni-Fe alloys [1-3].
Figure S3 TGA curves of FeS\textsubscript{2}@C, FeS\textsubscript{2}@RGO-1, FeS\textsubscript{2}@RGO-2 and FeS\textsubscript{2}@RGO-3.

TGA curves were carried out to evaluate the carbon content in the composite, as shown in Fig. S3. After being heated to 700 °C, the weights of the samples become stable, and 63.4%, 59.0%, 53.8% and 32.9% of the original weight are left for the final products for FeS\textsubscript{2}@C, FeS\textsubscript{2}@RGO-1, FeS\textsubscript{2}@RGO-2, FeS\textsubscript{2}@RGO-3, respectively. Due to the oxidation of FeS\textsubscript{2} to Fe\textsubscript{2}O\textsubscript{3} while the carbon to carbon dioxide, the carbon content of FeS\textsubscript{2}@C, FeS\textsubscript{2}@RGO-1, FeS\textsubscript{2}@RGO-2, FeS\textsubscript{2}@RGO-3 can be calculated, and corresponding values are 4.9%, 11.5%, 19.3% and 50.7%.
Figure S4 SEM images of (a) FeS$_2$@C, (b) FeS$_2$@RGO-1 and (c) FeS$_2$@RGO-3

Figure S5 Coulombic efficiencies of FeS$_2$@C, FeS$_2$@RGO-1, FeS$_2$@RGO-2 and FeS$_2$@RGO-3 at 50 mA g$^{-1}$. 
Figure S6 Long-term cycling performance of FeS$_2$@RGO-1 at 500 mA g$^{-1}$

Figure S7 Galvanostatic charge-discharge curves of FeS$_2$@RGO-2 electrode at different current densities.
Figure S8 EIS of FeS$_2$@C, FeS$_2$@RGO-1, FeS$_2$@RGO-2 and FeS$_2$@RGO-3 after 10 cycles.

Figure S9 (a) HRTEM image of FeS$_2$@RGO-2 electrode when charging to 3.0 V and (b) the corresponding SAED image in the first cycle.
Figure S10 SEM images of FeS$_2$@RGO-2 electrodes. (a)-(b) before cycles, (c)-(d) after a number of cycles.

Reference