Submitted to New Journal of Chemistry

Electronic Supplementary Information (ESI)

Three-Dimensional Graphene Hydrogels Supported Ultrafine RuO$_2$ Nanoparticles for Supercapacitor Electrodes

Yuying Yang, Yarong Liang, Yadi Zhang, Ziyu Zhang, Zhiming Li,

Zhongai Hu$^*$

Key Laboratory of Eco-Environment-Related Polymer Materials of Ministry of Education, Key Laboratory of Polymer Materials of Gansu Province, College of Chemistry and Chemical Engineering, Northwest Normal University, Lanzhou, Gansu 730070, PR China
1. Photograph of RuO₂/RGO composite

![Photograph of RuO₂/RGO composite](image1.png)

Fig S1 the photograph of RuO₂/ RGO composite

Fig S1 shows the shape of the RuO₂/RGO composite. As seen from the Photographs, with the increase of RuO₂ content in the composite, the product was no longer cylindrical shape.

2. TG analyses of RuO₂/RGO composite

![TG curves of the RuO₂/ RGO](image2.png)

Fig S2 TG curves of the RuO₂/ RGO

Fig S2 shows the TG curves of the RuO₂/RGO composite. On the TG curves, two steps of weight loss are found. The first step occurs at near 100 °C, which is due to evaporation of physically adsorbed water. The large weight loss at about 350 °C is attributed to the removal of RGO from the composites. After 400 °C, the TG traces
are stable with no further weight loss, indicating the RGO completely removed from the composites. The estimations based on the TG curves indicate that mass ratio of the RuO$_2$ in the composite is 33.2%.

3. **SEM of RuO$_2$/RGO composite (the mass ratio of the RuO$_2$ in the composite is 33.2%)**

![SEM image of RuO$_2$/RGO composite](image)

**Fig S3 FESEM images of RuO$_2$/RGO composite**

4. **XPS of the RuO$_2$-15%/RGOH**

![XPS spectrum](image)

**Fig S4 XPS of the RuO$_2$-15%/RGOH**

**Fig. S4** shows the peak fitted XPS spectra of Ru 3d peaks obtained from the RuO$_2$-15%/RGOH. Spectrum displays the characteristic shape of the Ru3d doublet,
which exhibits two relatively narrow peaks corresponding to the 5/2 and 3/2 spin orbit components. Moreover, the Ru 3d 5/2 peak, which does not overlap with Ru 3d 3/2 and C1S peaks appears at 281.0 eV, which corresponds to the binding energy of Ru$^{4+}$ and suggests the presence of RuO$_2$ in the composites$^3$. 