Electronic Supplementary Information (ESI)

Actuator materials based on graphene oxide/polyacrylamide composite hydrogels prepared by *in situ* polymerization

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Measurement of bending angles of the GO based hydrogel in an electric field

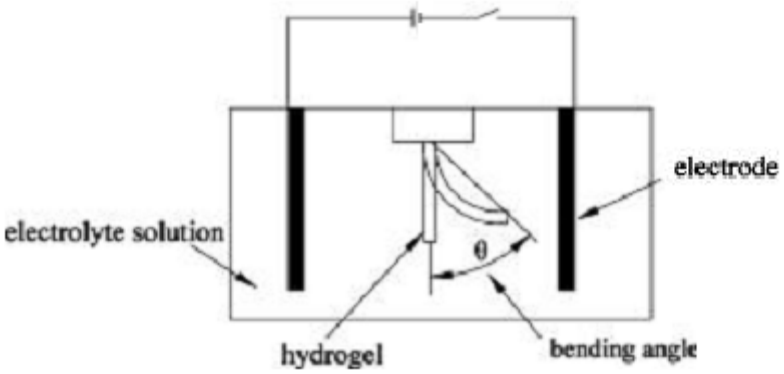


Fig. S1. A schematic diagram of the equipment used for studying the actuating property of the GO based hydrogel in an electric field

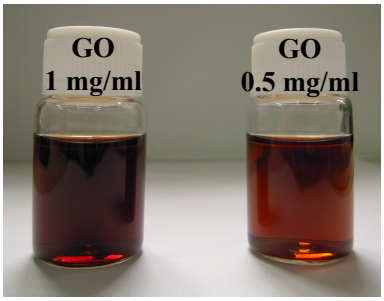


Fig. S2**.** Optical photos of stable GO aqueous suspensions

Characterization of GO

The GO was characterized by high resolution transmission electron microscopy (TEM). The GO sample for TEM observation was prepared by placing a drop of GO suspension (redispersed in distilled water), onto a carbon coated copper grid, which was then dried under ambient conditions prior to being introduced into the TEM chamber (TECNAI G2F20, accelerating voltage of 200 kV). X-ray powder diffraction (XRD) analysis was conducted on a BDX3300 X-ray diffractometer at a scanning rate of 4°/min with 2θ ranging from 10° to 70°, employing Cu Kα radiation (λ = 0.15418 nm). XPS was conducted on an x-ray photoelectron spectrometer (PHI1600 ESCA System, PERKIN ELMER, USA). Raman measurements were performed with a high resolution inVia Raman Microscope (RENISHAW, UK), in a backscattering configuration.

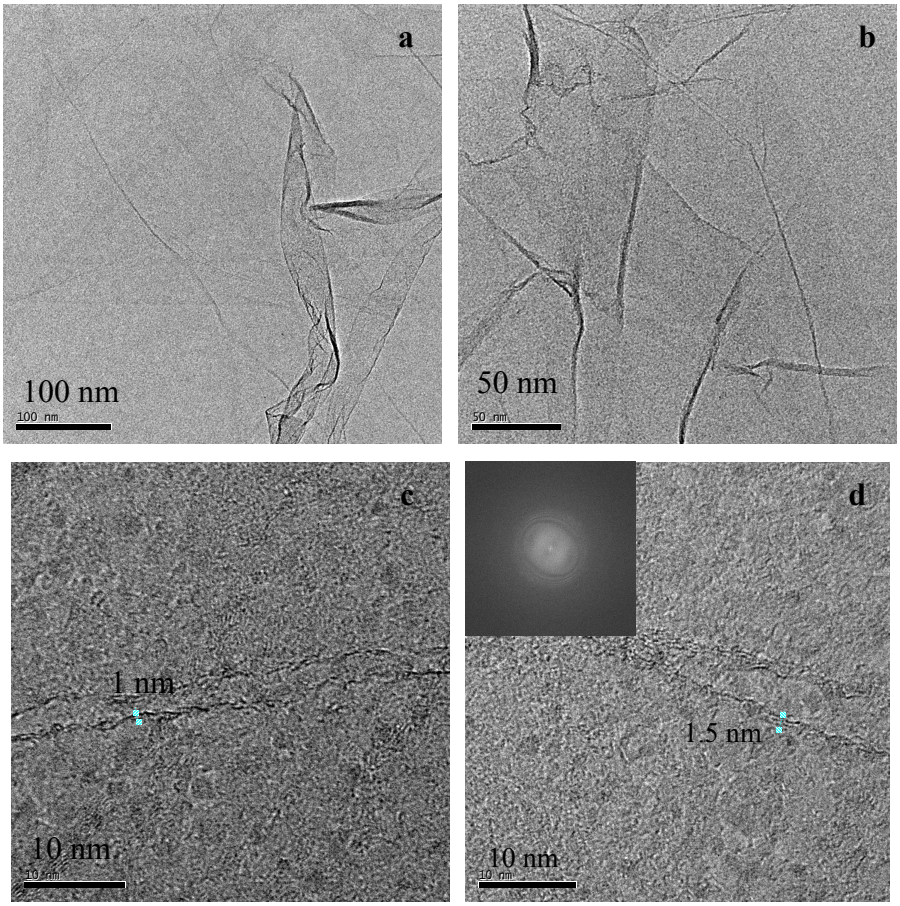


Fig. S3. TEM images and crystal diffraction pattern (inset image) of GO

TEM images show that the GO nanosheets have a thickness of 1 to 1.5 nm and their surface is full of wrinkles. Since the lattice lines corresponding to a single layer of graphene have a thickness of 0.34 nm, the wrinkled GO nanosheets in Fig. S3c and S3d should be two and three layers, respectively. The inset image in Figure S3d clearly illustrates the amorphous nature of the GO nanosheets. Therefore the GO nanosheets prepared in our lab are amorphous with several layers of thickness owing to the chemical oxidation.

XRD spectra for GO and natural graphite are shown in Fig. S4. The GO has a peak centered at 2θ = 12.2° corresponding to an (002) inter-planar spacing of 7.75 Å, but the intense graphite peak at 2θ = 30.8° is absent. This indicates that GO is formed with a considerable degree of oxidation.

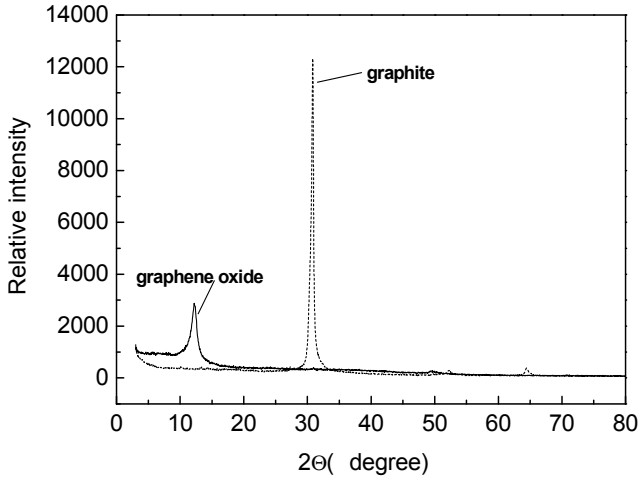


Fig. S4. XRD patterns of GO and natural graphite.

XPS analysis of GO in Fig. S5a shows a C/O ratio of 2.73/1. The C1s XPS spectra of GO in Fig. S5b clearly indicate a considerable degree of oxidation with three components that correspond to carbon atoms in different functional groups: non-oxygenated ring Cs (284.75 eV), the Cs in C-O bonds (286.84 eV) and the Cs in carboxyl groups (O-C=O, 288.69 eV). The atomic ratio of the carbon in the above three states is 11.7:7.2:1. Notably, the wide range of oxygen functional groups on both the basal planes and the edges of the GO nanosheets allow it to be readily exfoliated to yield well-dispersed suspensions of the individual GO nanosheets in both water and organic solvents. This provides more possibilities for applications in materials science

and electronic devices.

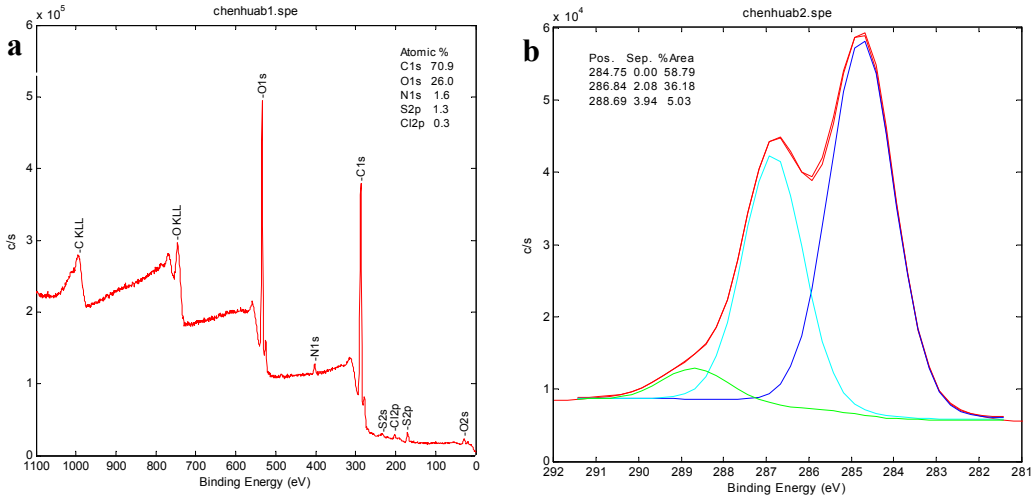
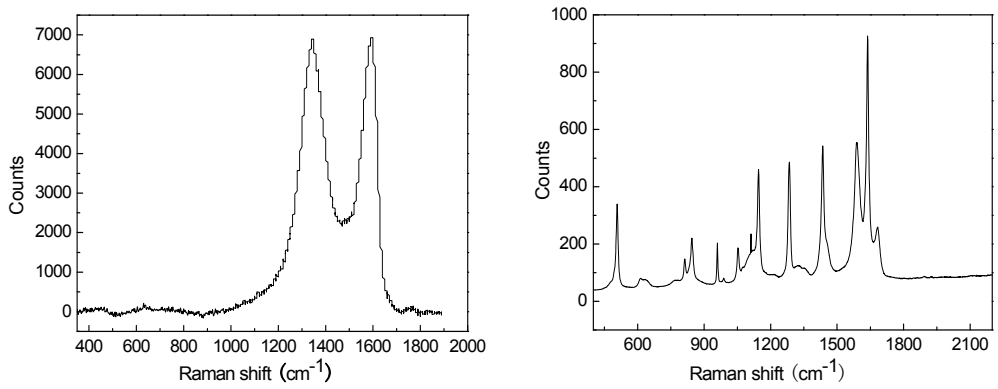
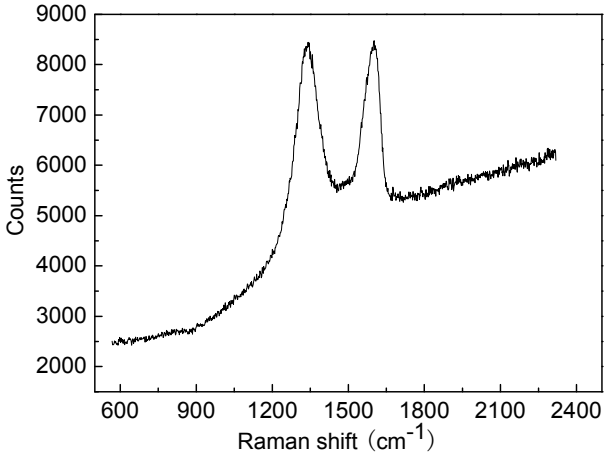


Fig. S5. XPS spectrum of GO (a) and deconvoluted XPS spectra of C1s (b).



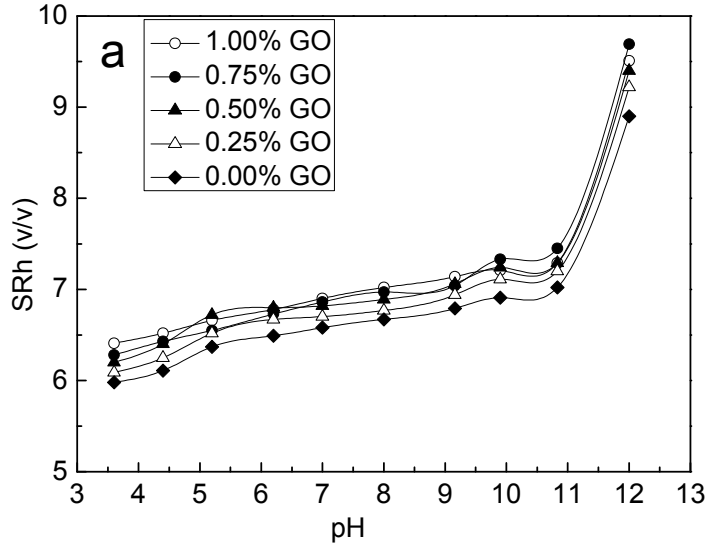
(a) (b)

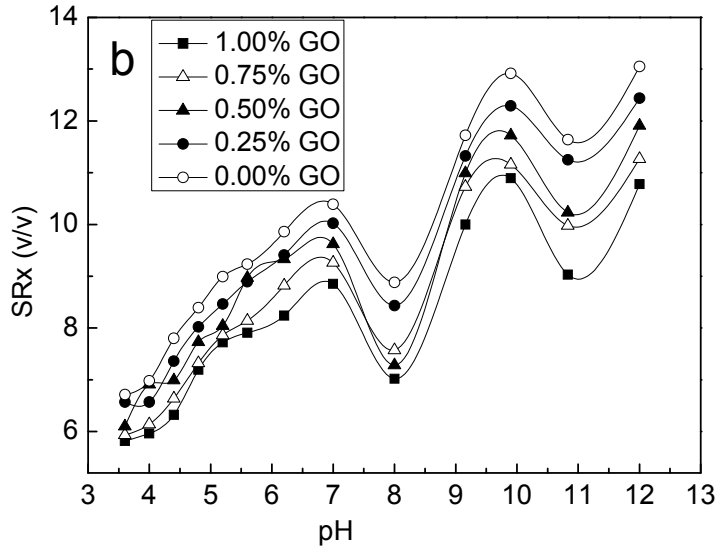


(c)

Fig.S6. Raman spectra of GO (a), PAM (b) and GO/PAM

Fig. S7. Photographic images of GO-g- PAM (left) and reduced GO-g-PAM (right)





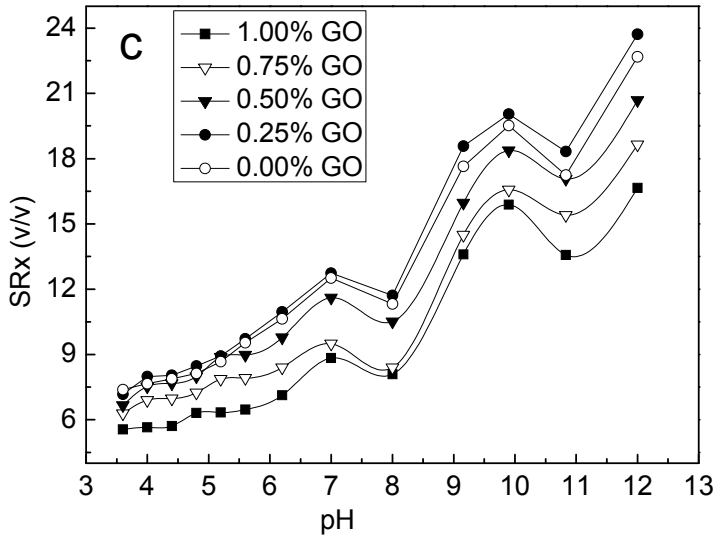


Fig. S8 Swelling ratio of GO/PAM and GO/PAM-co-PAA xerogel in different pH value solution. (a) PAA/PAM= 0/10; b) PAA/PAM = 1/9; c) PAA/PAM = 2/8