## **Experimental section**

**Materials.** Graphite flake (99.8%, 325 mesh) was provides by Alfa, L-cysteine and L-lysine were provided by Aladdin. All the reagents were used without further purification.

## Preparations.

**Graphene oxide (GO).** GO was prepared from graphite flake by a modified Hummers method.<sup>S1</sup> In brief, the graphite flake and NaNO<sub>3</sub> were added to cooled 98 wt% H<sub>2</sub>SO<sub>4</sub> under stirring, followed by a gradual addition of KMnO<sub>4</sub>. The mixture was continuously stirring at room temperature for 5 days. After that, the reaction was diluted by slow addition of H<sub>2</sub>O and terminated by addition of 30% H<sub>2</sub>O<sub>2</sub> solution. The product was collected by centrifugation and washed repeatedly with diluted HCl. The resultant GO was suspended in water to give a brown dispersion and subjected to dialysis to completely remove the residual salts and acids.

**RGO-based hydrogel.** In a typical procedure, 200 mg of L-cysteine (or L-lysine) was added to a GO suspension (1.4 mg mL<sup>-1</sup>) and the mixture was bath sonicated for 1 h. The mixture was put at a 100 mL Teflon liner, sealed in the stainless steel autoclave and heated at 160 °C for 10 h. After cooling to room temperature, the 3D black monolith was taken out, washed with distilled water, and freeze-dried into an aerogel for further use. They were labeled cys-RGO and lys-RGO, respectively.

## Characterizations

Powder X-ray diffraction (XRD) data were collected using a Bruker D8 Advance X-ray diffractometer (Cu-K $\alpha_1$  irradiation,  $\lambda$ = 1.5406 Å). FT-IR spectra were recorded in transmittance mode with a resolution of 4 cm<sup>-1</sup> using a Nicolet Nexus 670 FTIR spectrometer and 25 mg of catalyst. X-ray photoelectron spectroscopy (XPS) measurements were performed on a PHI Quantum 2000 XPS system with a monochromatic Al K<sub> $\alpha$ </sub> source and a charge neutralizer. All the binding energies were referred to the C 1s peak at 284.6 eV of the surface adventitious carbon. Raman spectroscopy was performed using an invia-Reflex Micro-Raman Spectroscopy system (Renishaw Co.) with 532 nm line of an Ar ion laser at room temperature. The morphology of the sample was characterized by a field emission scanning electron microscopy (SEM, JSM-6700F). BET surface area was carried out on an ASAP2020M apparatus (Micromeritics Instrument Corp., USA). The optical contact angle of the sample was characterized by OCA20 optical contact angle device. The concentrations of Cd<sup>2+</sup> and Pb<sup>2+</sup> were determined by inductively coupled plasma optical emission spectrometry (ICP-OES, SpectrAA 220).

**Oil and Organic liquids Uptake Experiments.** The oil-adsorbent capacity of the aerogels was determined by weight measurements. The weighed samples were put into different kinds of oils and taken out by tweezers after 1 min. After removing the oil on the surface of the samples with filter paper, the samples were weighed again. The oil adsorption values were calculated from the differences of mass. The regeneration of adsorbent capacity was investigated in the same way after the oil-saturated samples were dried in an oven at 100 °C for 30 min.

Adsorption Isotherm Experiments for Heavy Ions. At room temperature, 10 mg lys-RGO aerogels were added into 50 mL of heavy ion-containing solution of different concentrations. The temperature was maintained at room temperature. After 20 h to reach complete adsorption equilibrium, the remaining concentrations of  $Cd^{2+}$  and  $Pb^{2+}$  were measured by the reported ICP-OES technique.

**Fig. S1** Photographs of the cys-RGO hydrogels with different L-cysteine concentration.



Fig. S2 Typical nitrogen sorption isotherms of cys-RGO aerogel.



Fig. S3 XPS spectra of cys-RGO aerogel in (a) S2p region and (b) C1s region.



The reduction degree of GO defined as the ratio of oxygen-bound carbon content in GO has also been determined based on the XPS results following the equation:

O-bound C % =  $(A_{C-O}+A_{O-C=O})/(A_{C-C}+A_{C-O}+A_{O-C=O})\times 100\%$ where  $A_{C-C}$ ,  $A_{C-O}$ , and  $A_{O-C=O}$  are the peak areas in the XPS spectra for thesp<sup>2</sup>-hybridized (C–C) and O-bound (C–O and O–C=O) carbon, respectively.





Fig. S5 Photographs of the lys-RGO hydrogels with different L-lysine concentration.



Fig. S6 TGA curves of cys-RGO aerogel and lys-RGO aerogel in air.



Fig. S7 XPS spectra of lys-RGO aerogel in (a) N1s region and (b) C1s region.



Fig. S8 XRD patterns for (a) GO, (b) cys-RGO aerogel and (c) lys-RGO aerogel.



Fig. S9 FTIR spectra of (a) GO, (b) cys-RGO aerogel and (c) lys-RGO aerogel.



**Fig. S10** The water contact angle of (a) the cys-RGO aerogels and (b) the lys-RGO aerogels with different amino acid concentration.



Fig. S11 Stress-strain ( $\sigma$ - $\epsilon$ ) curves of compressions on cys-RGO and lys-RGO aerogels.

**Fig. S12** (a) Gasoline can be removed by putting the cys-RGO aerogel in the oven at 100 °C for recycled use; (b) Zeta potential of the lys-RGO aerogel in an aqueous solution of different pH; (c) Cycling runs in the adsorption process of heavy metal ions over the lys-RGO aerogel.



Notes and references

S1 A. Lerf, H. Y. He and M. Forster, J. Phys. Chem. B, 1998, 102,4477-4482.