Electronic Supplementary Material (ESI) for Journal of Materials Chemistry A.

Supporting information

A stable and long-lasting concentration cell based on reduced graphene oxide membrane and natural resource electrolyte

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Experimental Methods

Chemicals. Graphite powder (< 20 μm), hydriodic acid (57 wt. % in H_2O), and humic acid were purchased from Sigma-Aldrich. Potassium chloride, potassium nitrate, and sodium citrate were purchased from Alfa Aesar. The chemicals were used as received. All the solutions were prepared with deionized water.

Preparation of reduced graphene oxide membrane (RGOM). Before preparation of RGOM, graphene oxide (GO) dispersion was pre-synthesized from an improved modified Hummers method[S1]. Then 80 mL GO dispersion with a concentration of 0.9 mg/mL was added into a glass petri dish and dried at 50 °C in oven for 24 hours. Thus, graphene oxide membrane (GOM) was formed at the bottom of the glass petri dish. After that, 10 mL HI (57 wt. %) was added into glass petri dish and submerge the GOM. HI and GOM were sealed in the glass petri dish heated to 100 °C in oven for 1 hour to make sure the GOM was completely reduced to RGOM. The resultant RGOM was easily peeled off after washed with deionized water and dried at 80 °C in oven.

Characterization. The thickness of graphene oxide was measured by atomic force microscopy (AFM Cypher ES, Asylum Research). The thickness of RGOM was determined by cross-section SEM (SM-7600F). X-ray powder patterns were obtained by a Shimadzu XRD-6000 X-ray powder diffractomer with Cu K_a radiation. X-ray photoelectron spectroscopy spectra were recorded with ESCALAB 250 photoelectron spectrometer with Al K_α. Fourier transform infrared spectroscopy was carried out on IRPrestige-21 spectrometer (Shimadzu). Cyclic voltammogram curves were obtained

with a CHI660E electrochemical station. The voltage and current were collected with a Keithley 6517 electrometer.

S1 J. Chen, Y. Li, L. Huang, C. Li and G. Shi, *Carbon*, 2015, **81**, 826.

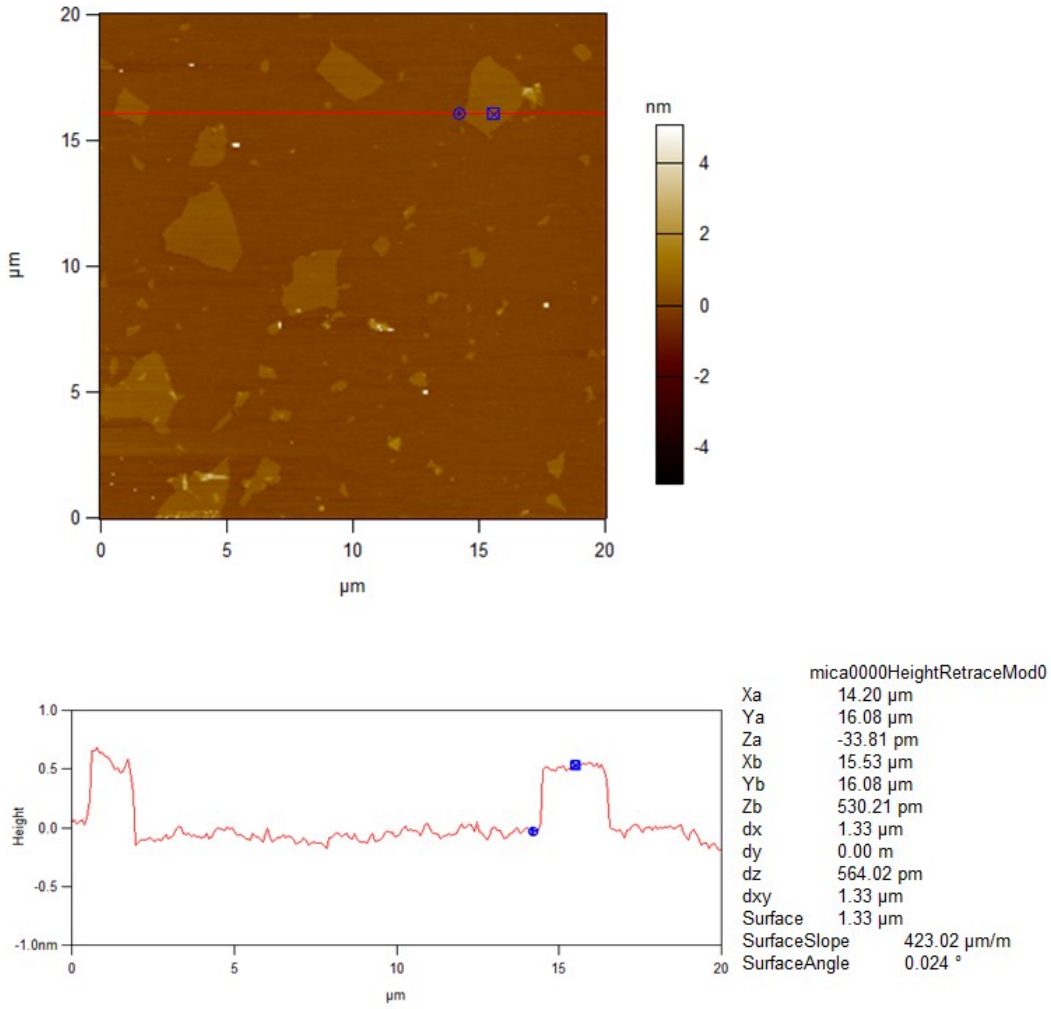

Fig. S1 AFM image of the GO dispersion.

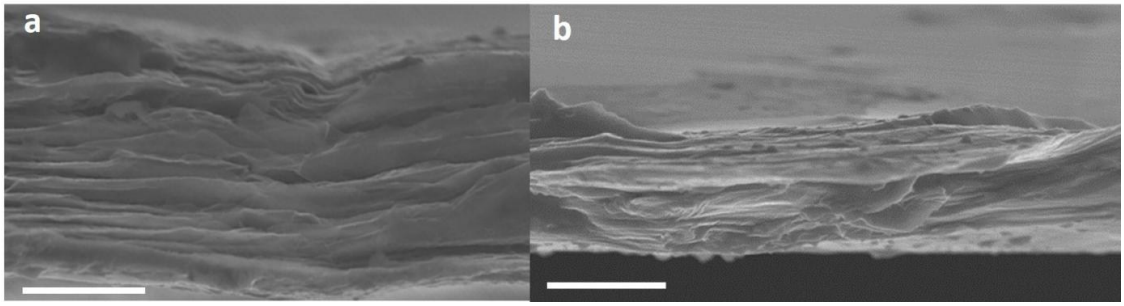

Fig. S2 Cross-sectional SEM images of RGOM with different thicknesses: a) 4 μm, b) 2 μm), scale bar: 2 μm.

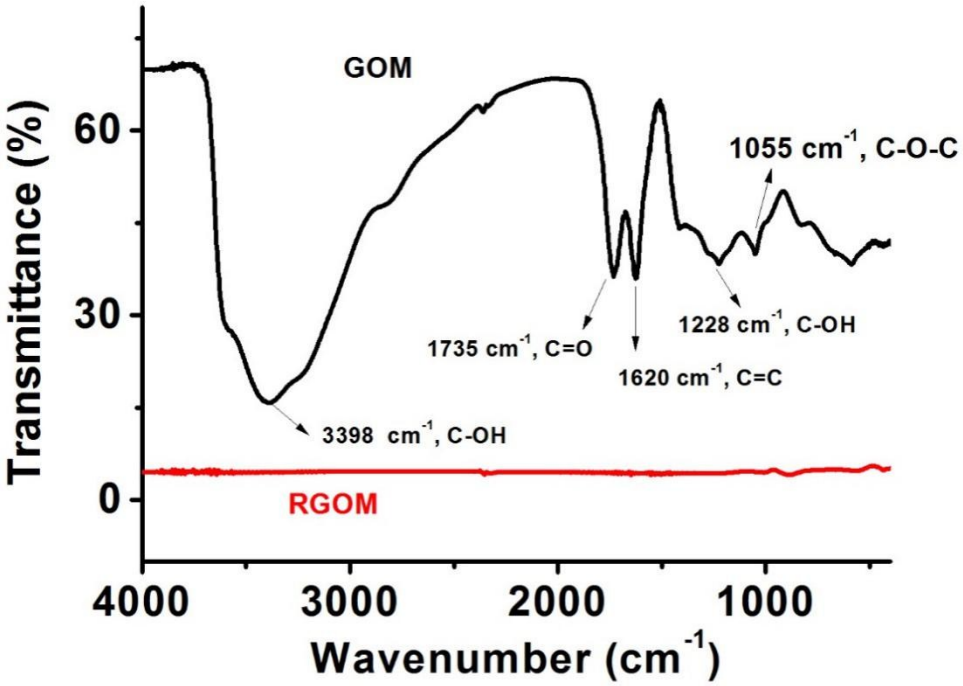

Fig. S3 FT-IR spectra of GOM and RGOM.

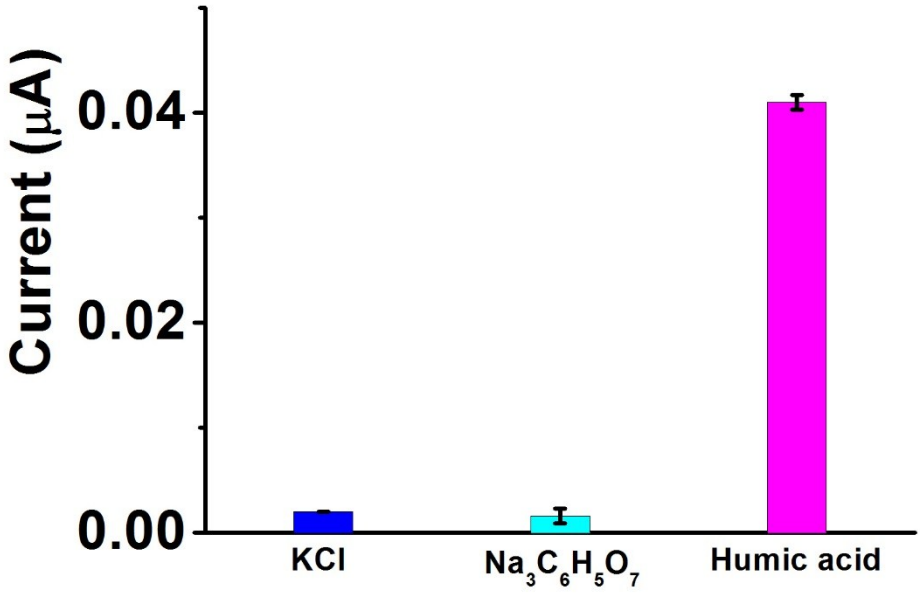

Fig. S4 Comparison of the short-circuit current of the concentration cell using different electrolytes including KCl, sodium citrate ($Na_3C_6H_5O_7$), and HA at a concentration of 1 mg/mL.

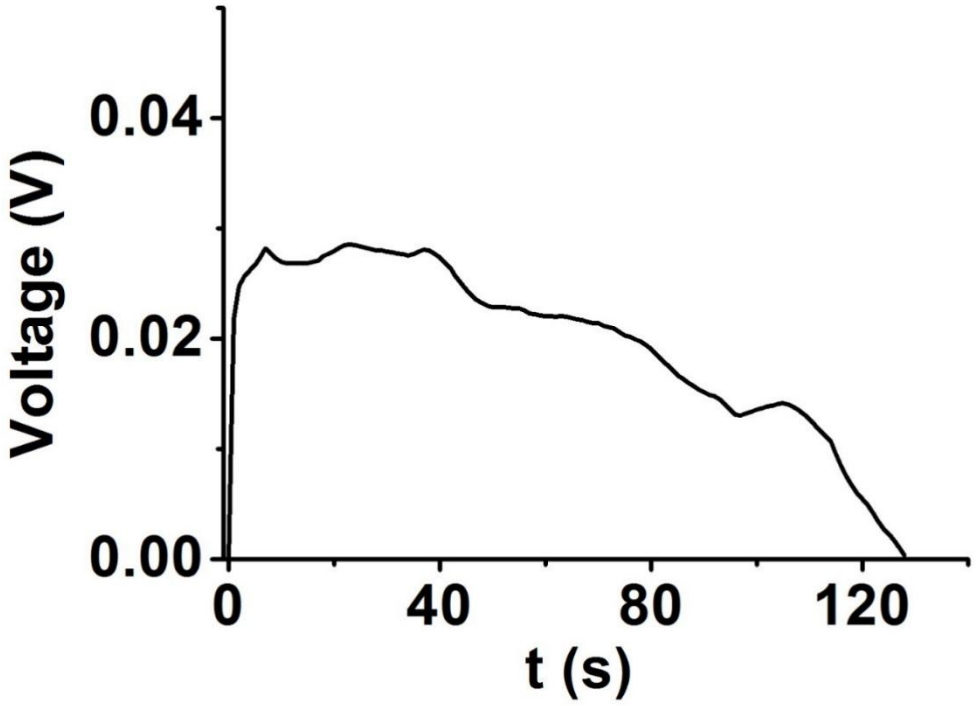

Fig. S5 Open-circuit voltage as a function of time for the concentration cell using 1 mg/mL KCl as the electrolyte.

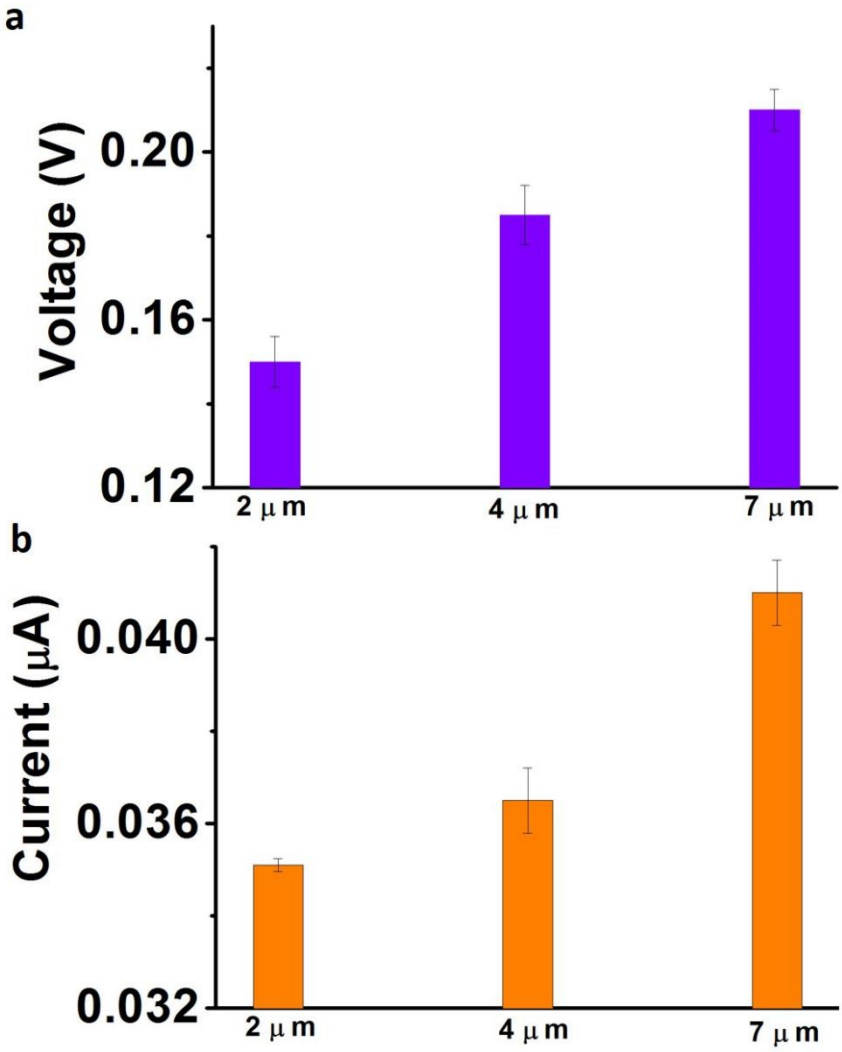

Fig. S6 Effect of the thickness of RGOM on the (a) open-circuit voltage and (b) short-circuit current of the concentration cell.

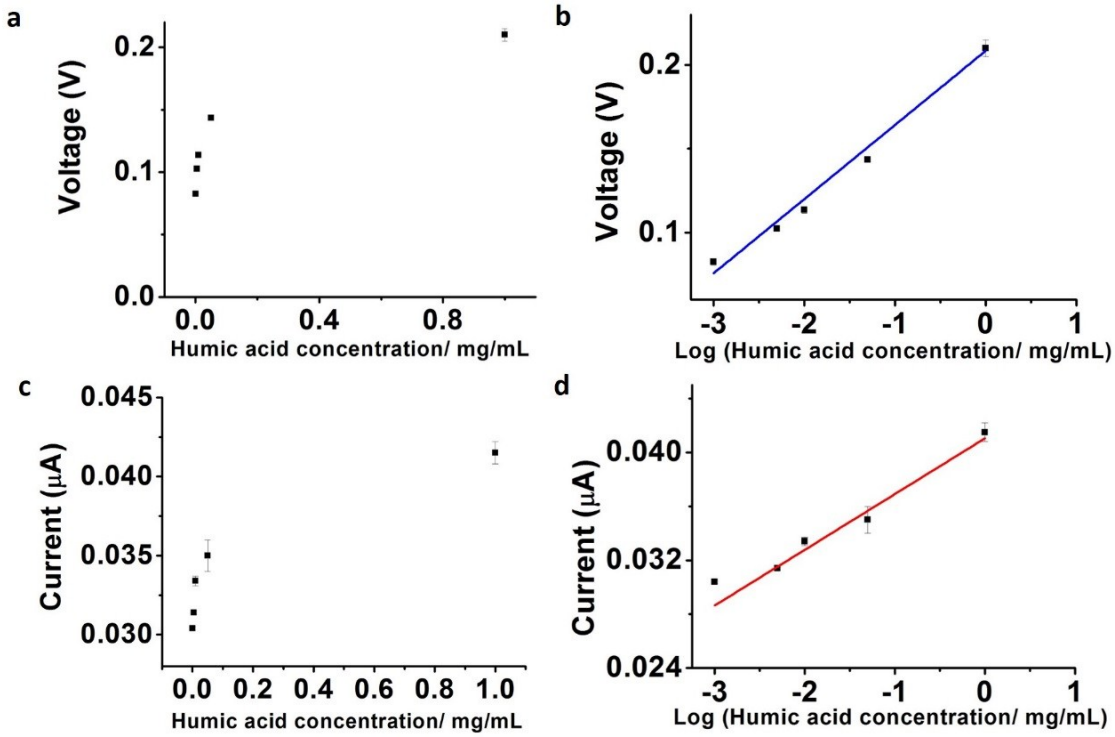

Fig. S7 Effect of the concentration of HA solution on the (a, b) open-circuit voltage and (c, d) short-circuit current of the concentration cell. The solid lines of c and d represent the linear fitting to equation.

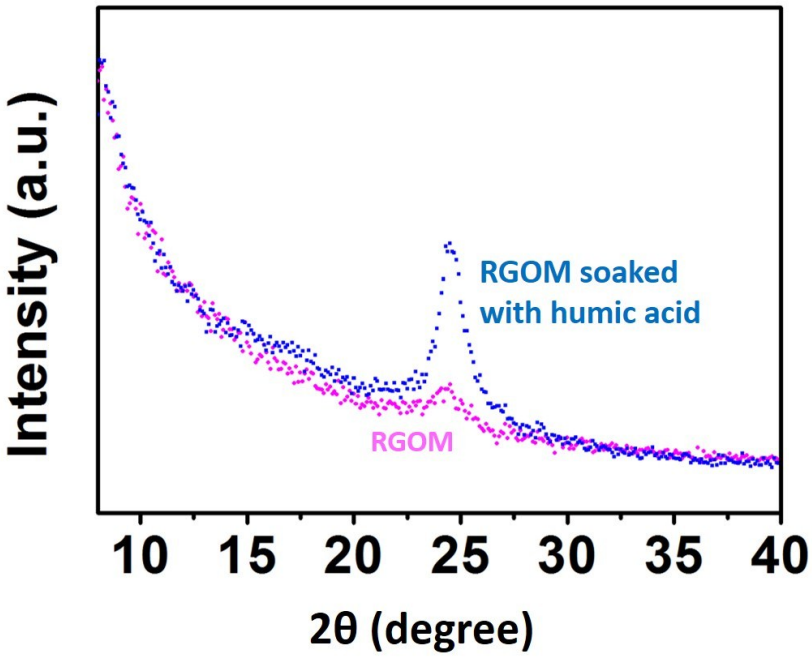

Fig. S8 XRD patterns of RGOM before (pink dots) and after (blue dots) soaking with 1 mg/mL HA solution for four days.

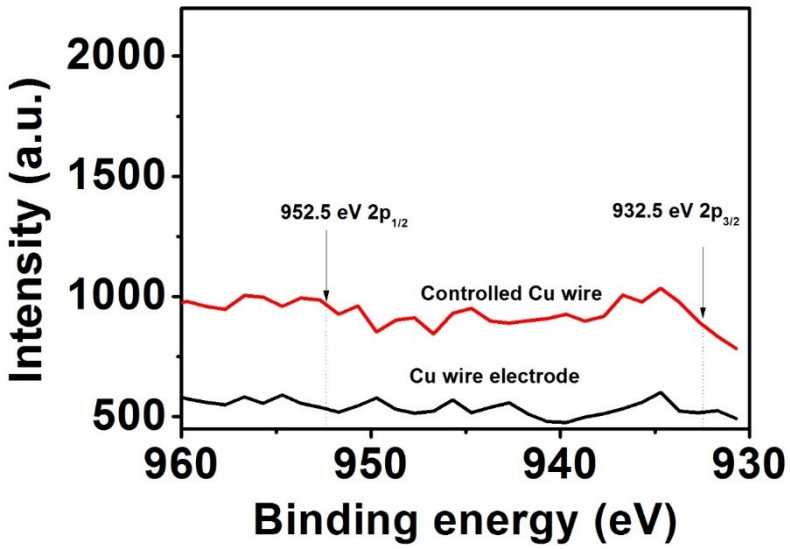

Fig. S9 X-Ray photoelectron spectra of the Cu 2p for controlled Cu wire and Cu wire electrode samples.