Supplementary Information

Gelation of uranyl ions and gel-derived uranium oxide nanoparticles for gas sensing

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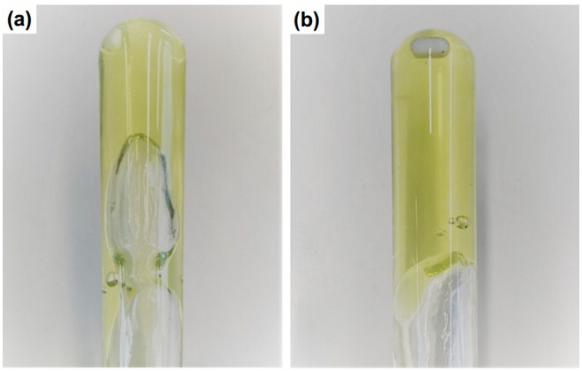

Fig. S1 Thixotropy properties of uranyl EG gel (a) the gel after shaken and (b) the gel recovery from solution state in minutes.

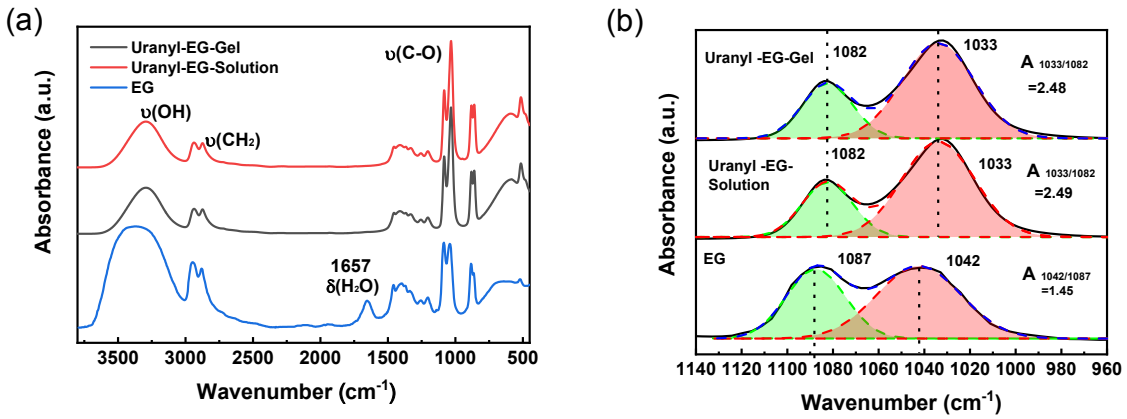

Fig. S2 FI-IR spectroscopy of uranyl-ethylene-gel and uranyl-ethylene-solution.

Since the very low concentration (3.3~13.2 mmol/L) of uranyl ion in the gel and the

precursor solution, the vibration signal of U=O bond was submerged in the signals of the solvent and hard to be distinguished. As shown in Fig. R2(a), the patterns in the IR spectra were mainly contributed by the solvent, ethylene glycol (EG). In the spectrum of EG, the peak at 1657 cm^{-1} (bending vibration mode of H-O-H) implied the existence of residual water. However, in the spectra of uranyl-EG solution and uranyl-EG-gel, that signal of water molecular almost disappeared. It was likely caused by the water consumption from the hydrolysis of uranyl ion, according to the following formula.

$$m UO_2^{2+} + n H_2O \rightarrow [(UO_2)_m(OH)_n]^{(2m-n)+} + m H^+$$

Besides, the *v*(C-O) peaks of EG were different in the spectra, which implied the conformation change of EG.

The two bands at 1033 and 1082 cm^{-1} were assigned to the C-O stretching vibration modes related to the trans- and gauche- conformation of EG. [1] The intensities of the two bands were sensitive to the molar ratios of water and EG. When the amount of water is low, the intermolecular hydrogen bonds between the EG molecules were dominant and the EG molecules mainly stayed in trans-conformation. When the content of water increases, the intermolecular hydrogen bonds were interrupted by the water molecules and the structure of most EG molecules changed to gauche- conformation.

In our measurement, the v(C-O) bands of EG appear at 1042 cm^{-1} and 1087 cm^{-1} and the peak area ratio (A_{1042}/A_{1087}) is 1.45. [1] For the uranyl-EG-gel and uranyl-EG-solution, the v(C-O) bands are at 1033 cm^{-1} and 1082 cm^{-1} and the peak area ratio (A_{1033}/A_{1082}) is around 2.5. These values are coincident with the reported ones at low water concentration.[1] Therefore, in the uranyl solution and gel, the water content is low and most EG molecules stay in the trans-conformation forming the solvent network.

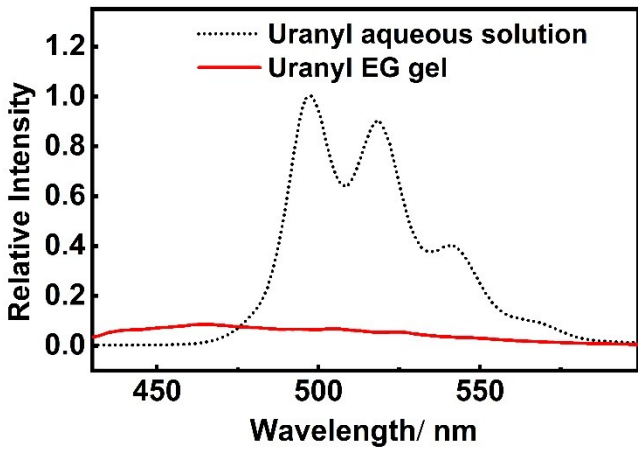

Fig. S3 Luminescence quenching of uranyl ion by EG, excitation wavelength: 375 nm.

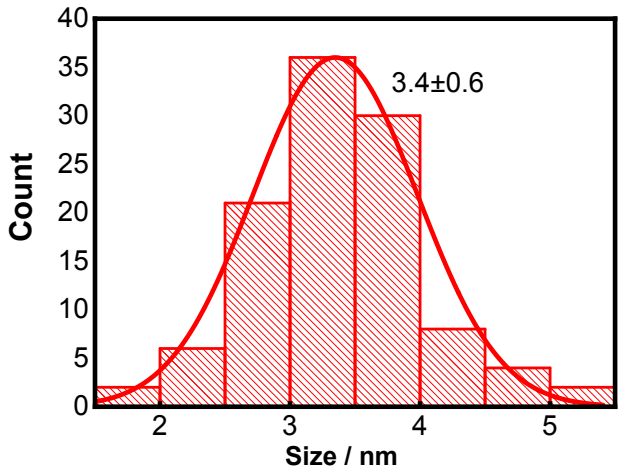

Fig. S4 Figure. Size distribution of the UO_2 nanoparticles from TEM images.

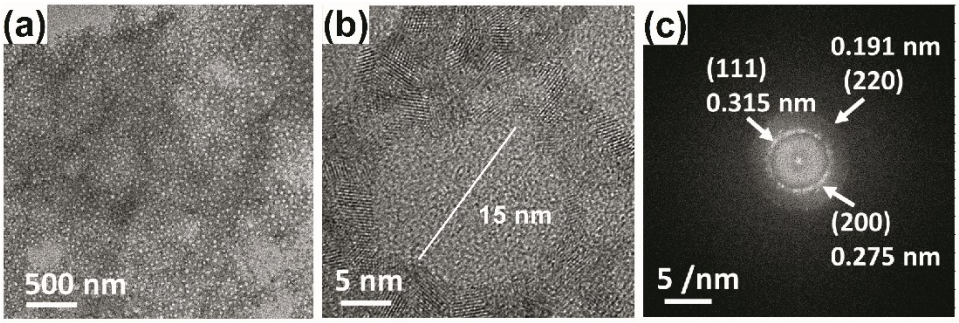

Fig. S5 TEM image of uranyl gel skeleton after photoreaction.

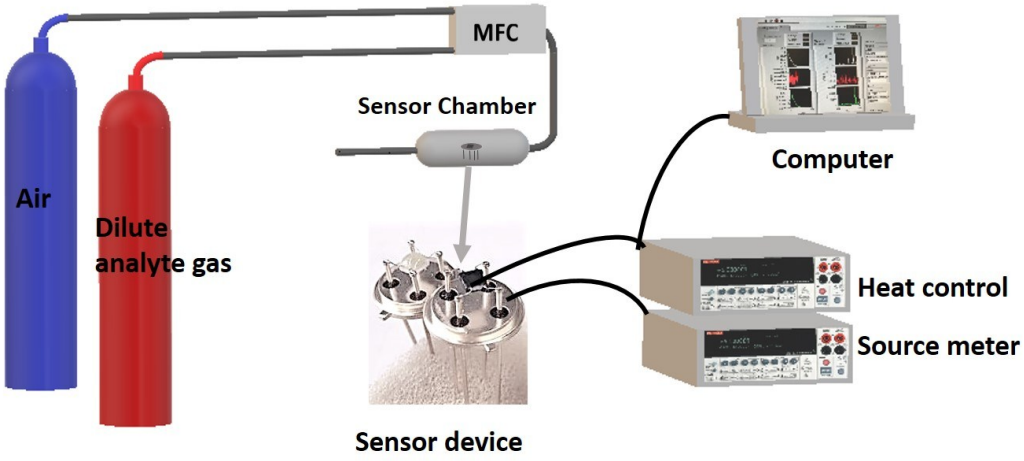

Fig. S6 Schematic illustration of the set up for the gas sensing measurements.

Fig. S7 Photograph of the electrode for Mott-Schottky measurement.

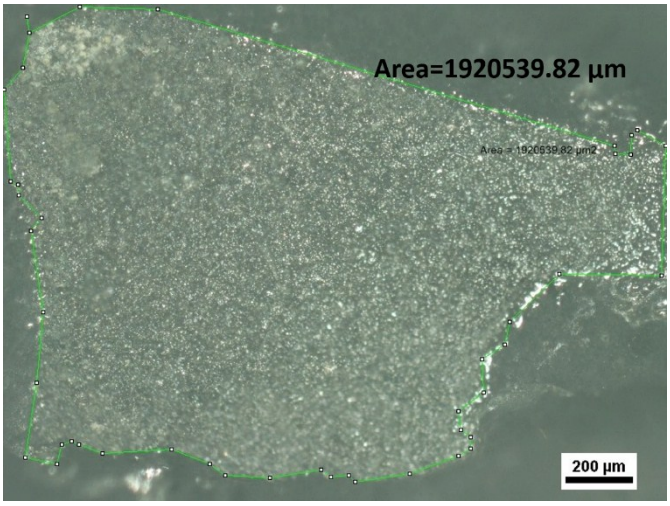

Fig. S8 Optical graph for area calibration of the electrode for Mott-Schottky measurement.

1. Y.-C. Guo, C. Cai and Y.-H. Zhang, *AIP Advances*, 2018, **8**, 055308.