Efficient gold recovery by a thiazolyl covalent organic framework

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EXPERIMENTS

Materials and general methods. All the organic monomers and ligand were purchased from Jilin Chinese Academy of Sciences -Yanshen Technology Co., Ltd. Others were purchased from Adamas Reagent, Ltd. and used as received without further purification. X-ray powder diffraction was collected by a Bruker AXSD8 Discover powder diffractometer at 40 kV, 40 mA for Cu Kλ (λ= 1.5406 Å). The simulated powder patterns were calculated by Mercury 1.4. Infrared Spectra (IR) were measured by a Bruker VERTEX70 spectrometer in the 500-4000 cm^{-1} region. The gas adsorption isotherms were collected on a Belsorp-max. Ultrahigh-purity-grade (>99.999%) N_2 gases were used during the adsorption measurement. SEM and EDS measurements were carried out using a Hitachi S-4800 microscope. The analyses of concentrations of metal ions in the solution was carried out by ThermoFisher iCap7600 ICP-OES instruments. X-ray photoelectron spectra (XPS) were collected by Thermo Scientific ESCALAB 250 Xi spectrometer. Solid-state NMR experiments were performed on Varian Infinityplus 300 solid-state NMR spectrometer (300 MHz).

Synthesis of ECUT-COF-29. Bdta (0.1 mmol, 60 mg), Tdm (0.2mmol, 24 mg) ,2 mL DMF were weighed into a Pyrex tube. Then the tube was placed in a 120 °C for 3 days. After cooling to room temperature, the precipitated was washed with a large amount of DMF and then methanol. The resulting powder was collected by filtration and dried at 80°C under vacuum overnight to obtain a red powder.

Photocatalytic reduction of gold (III). Au(III) solution was prepared by dissolving Sodium chloroaurate ($NaAuCl_4$, analytical reagent) in deionized water. Visible light was perpendicularly irradiated on the reaction vessel from a 350W Xe lamp with λ>400 nm.

In kinetics experiments, the Au solution with initial concentration of 100 ppm was used. The dose of adsorbent is 5 mg, while the Au solution is 50 ml. In addition, add 5 ml methanol solution and light for 2 h.

In the maximum adsorption capacity experiment, Au solutions with initial concentrations of 100 ppm, 200 ppm, 300 ppm, 400 ppm, and 500 ppm were used. The dose of the adsorbent is 5 mg, while the dose of the Au solution is 50 ml. In

addition, 5 ml of methanol solution is added, and light for 1 h.

In selective adsorption experiments, a 6-ions mixed solution contains both Au and other 5 metal ions with respectively initial concentration of 10 ppm were used. The dose of adsorbent is 5 mg, while the solution is 50 ml. In addition, add 5ml methanol solution and light for 1 h.

The adsorption amount, Q_e (mg/g), was calculated by the difference of the Au(III) equilibrium concentration before and after adsorption (see equation 1):

$$Q_e = \frac{(C_0 - C_e) \times V}{m} \qquad (1)$$

where C_0 (mg/L) and C_e (mg/L) are the initial concentration and equilibrium concentration of Au in the solutions, respectively; V (L) is the volume of testing solution and m (g) is the amount of sorbent.
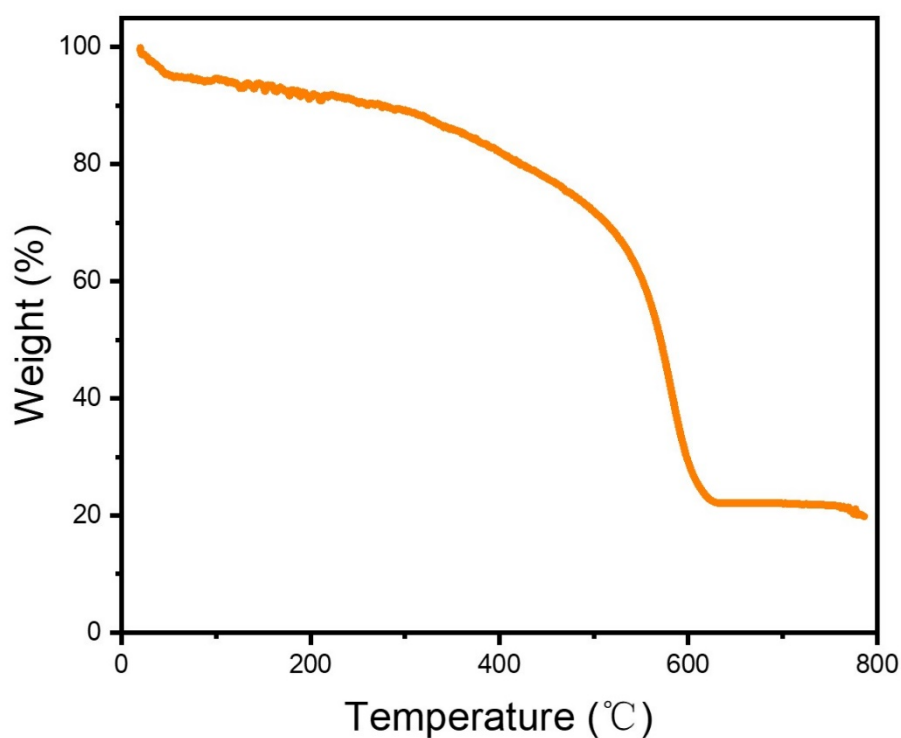
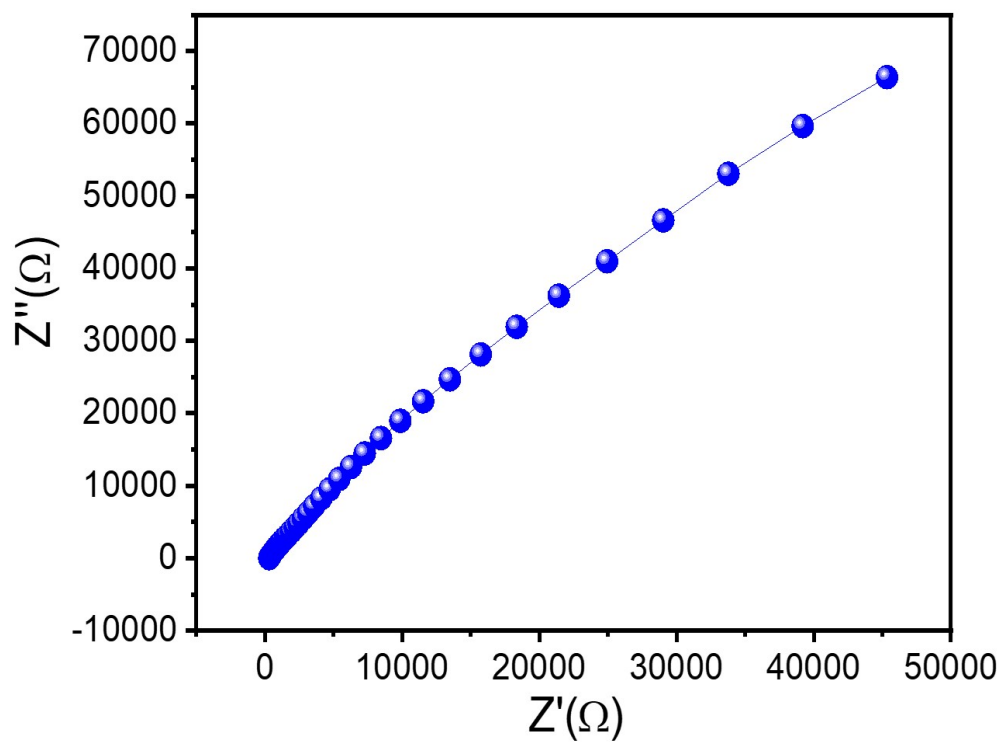**Fig. S1** TGA curve of ECUT-COF-29.

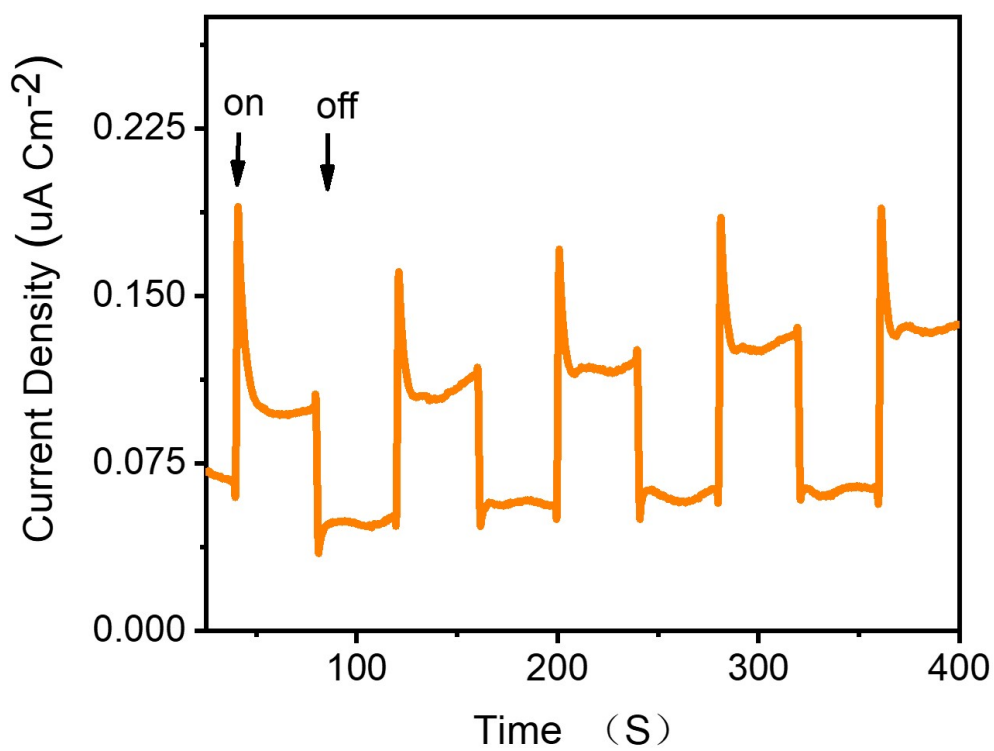**Fig. S2** EIS Nyquist plots of ECUT-COF-29.

Fig. S3 Transient photocurrent response.

Fig. S4 Gold fragments in the sample after photocatalysis.
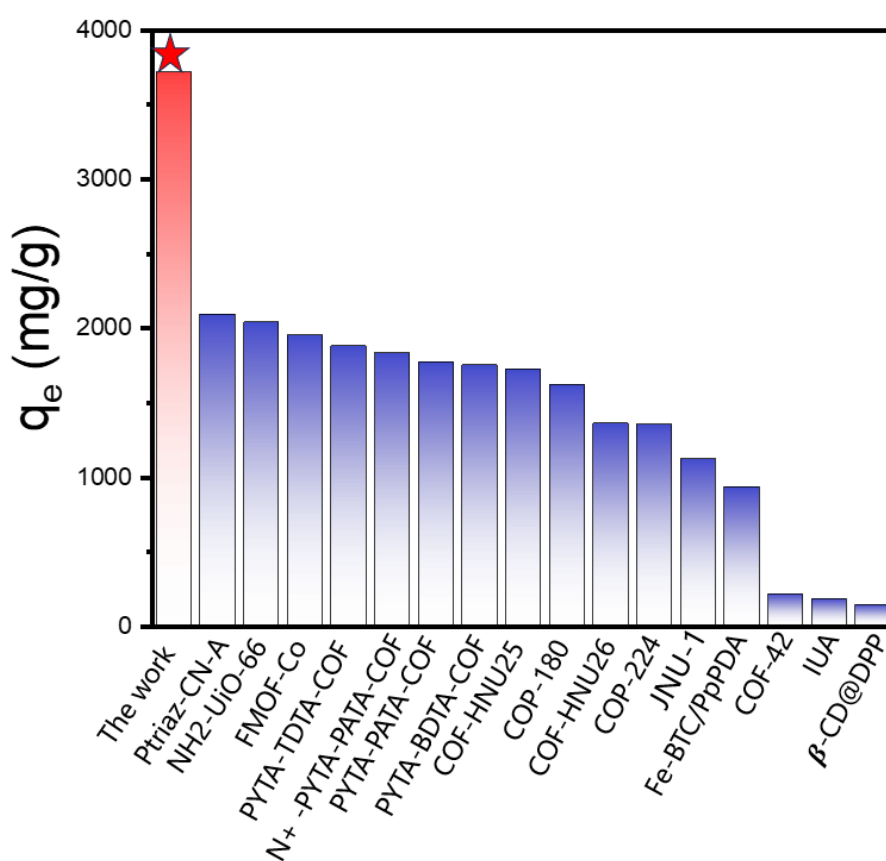

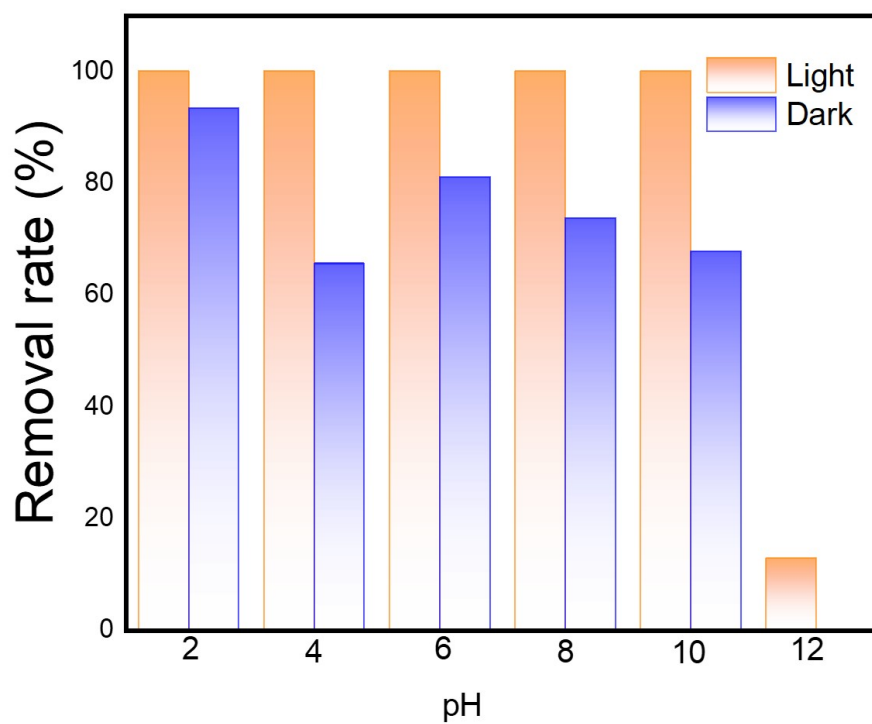**Fig. S5** A comparison in gold uptake capacity among reported adsorbents and our case.

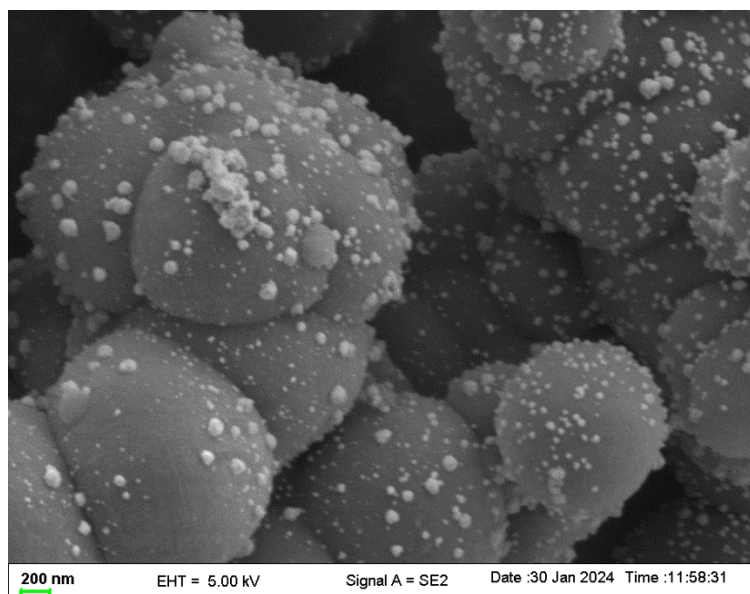**Fig. S6** Reduction rate of gold at different pH.

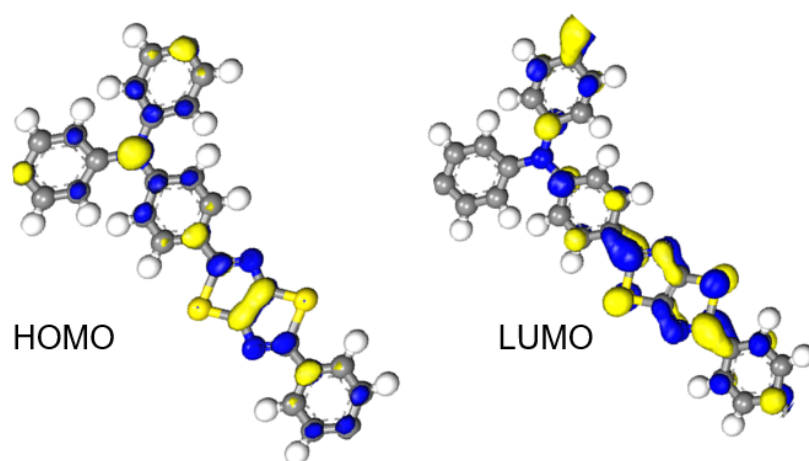**Fig. S7** The SEM-EDS images of samples after photocatalysis.

Fig. S8 HOMO and LUMO of ECUT-COF-29.