

**Stable metal-organic frameworks modulated by doping Tb<sup>3+</sup> for multi-hazard  
detection and capture**

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## **Experimental Procedures**

### **Photophysical Measurements**

Samples were prepared for photophysical measurements by grinding the powder products to uniform particle size. Each sample of Tb@UiO-66-(COOH)<sub>2</sub> (1 mg) was suspended in aqueous solutions (2 mL, 10<sup>-3</sup> M~10<sup>-7</sup> M) of M(NO<sub>3</sub>)<sub>z</sub> (M<sup>z+</sup> = Ag<sup>+</sup>, Co<sup>2+</sup>, Ni<sup>2+</sup>, Cu<sup>2+</sup>, Fe<sup>3+</sup>, Sn<sup>4+</sup>, UO<sub>2</sub><sup>2+</sup>), and then sonicated for 10 min to obtain the uniform metal ion-incorporated suspensions for luminescent measurements.

### **UO<sub>2</sub><sup>2+</sup> ion adsorption test**

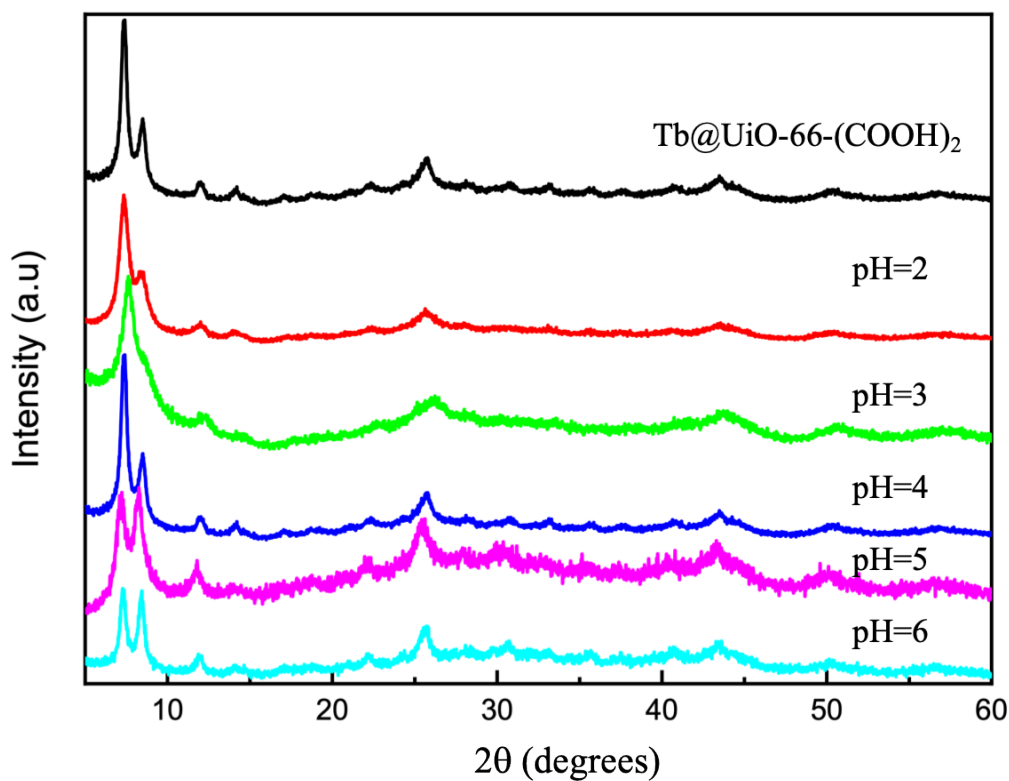
Note that the UO<sub>2</sub><sup>2+</sup> is present in the form of a complex with a positive charge in solution. Uranyl carbonate becomes predominant species at pH higher than 6.5 and the negative charge of uranyl

carbonate will compromise the adsorption on the MOF's surface. Therefore, we decided to perform the batch experiments in the pH range from 2 to 6. In a typical experiment, 5 mg adsorbent and 30 mL  $\text{UO}_2^{2+}$  ( $50 \text{ mg}\cdot\text{L}^{-1}$ ) solution with appropriate concentration and pH value were added to a 250 mL flask placed in an air bath oscillator (180 rpm) at 308 K. The pH was adjusted with 0.1 M negligible volume of HCl and  $\text{Na}_2\text{CO}_3$ . After adsorption of  $\text{UO}_2^{2+}$ , the residual concentration of  $\text{UO}_2^{2+}$  in the solution was analyzed by UV-Vis and monitoring the absorption at  $\lambda_{\text{max}} = 650 \text{ nm}$  (1 mL Arsenazo (III) as chromogenic agent). The equilibrium adsorption capacity of  $\text{UO}_2^{2+}$  ( $q_e$ ) and the removal efficiency (%) was calculated as follows:

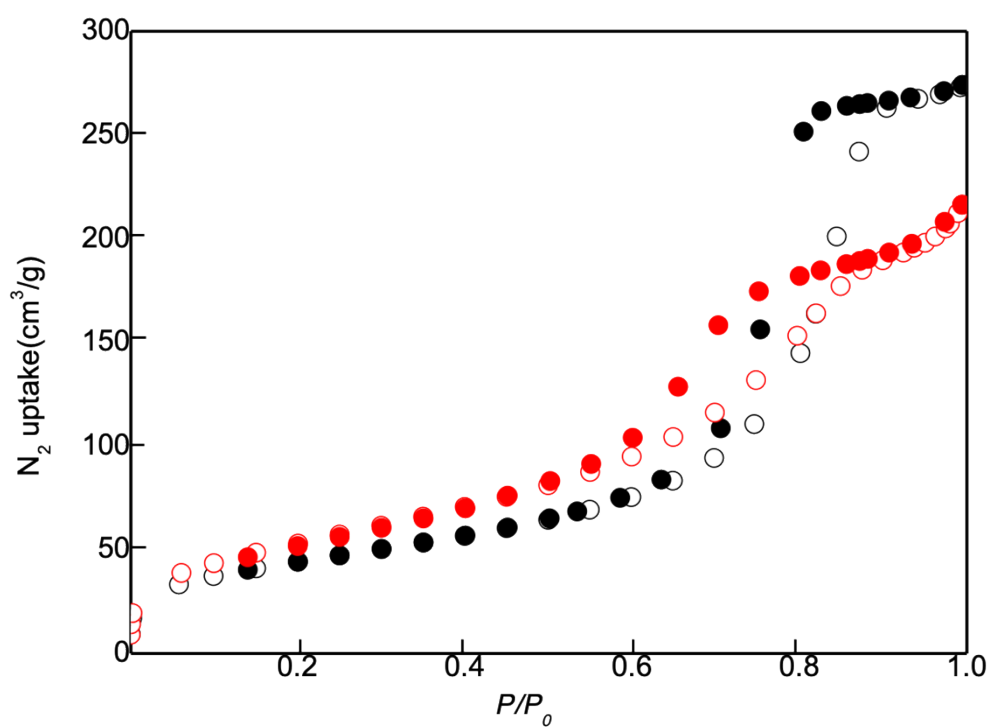
$$q_e = \frac{(C_o - C_e)V}{m} \quad (1)$$

$$(\%) = \frac{(C_o - C_e)}{C_o} \times 100\% \quad (2)$$

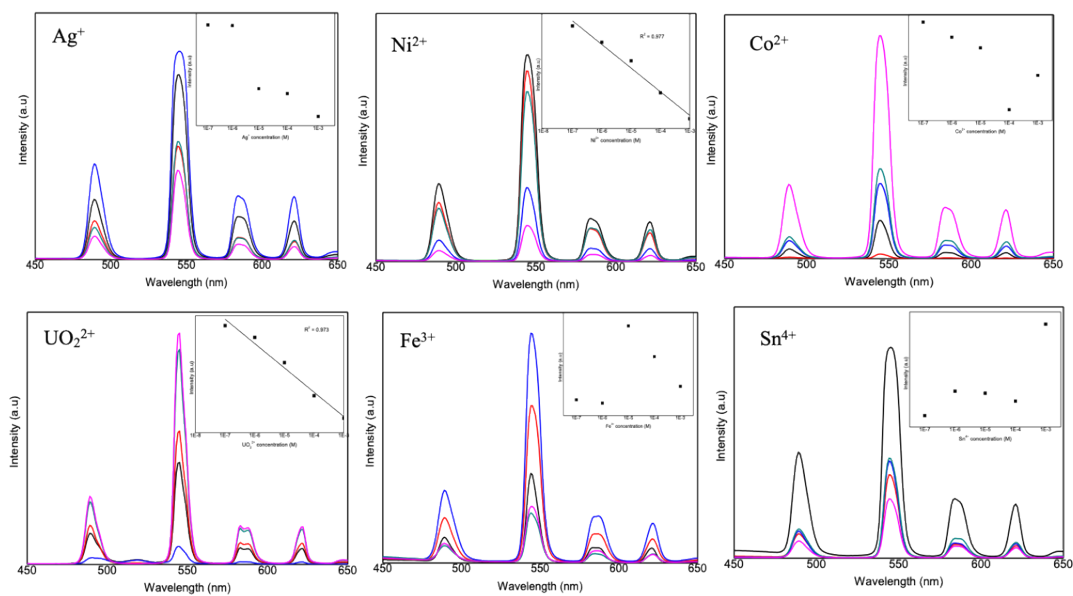
where  $C_o$  and  $C_e$  are the initial and equilibrium concentrations of  $\text{UO}_2^{2+}$  (mg/L), respectively,  $V$  is the liquid phase volume (L), and  $m$  is the amount of adsorbent (g). All the flasks were closed to avoid evaporation.



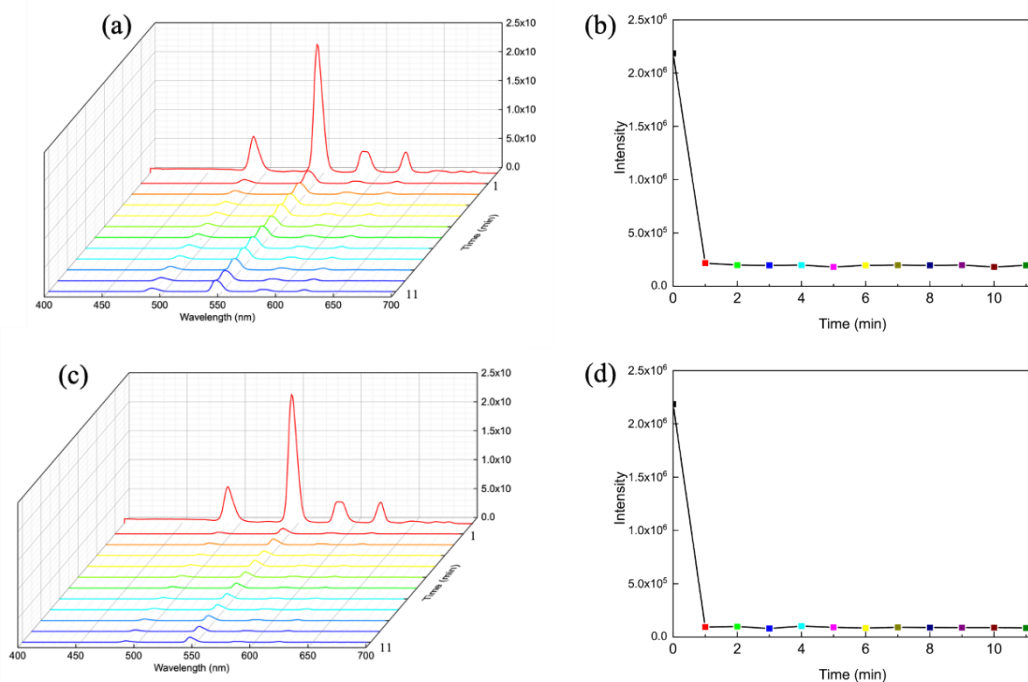
**Fig. S1** PXRD patterns of  $\text{Tb@UiO-66-(COOH)}_2$  after immersion in aqueous solutions at pH values ranging from 2 to 6.



**Fig. S2**  $N_2$  adsorption of  $UiO-66-(COOH)_2$  (black) and  $Tb@UiO-66-(COOH)_2$  (red).



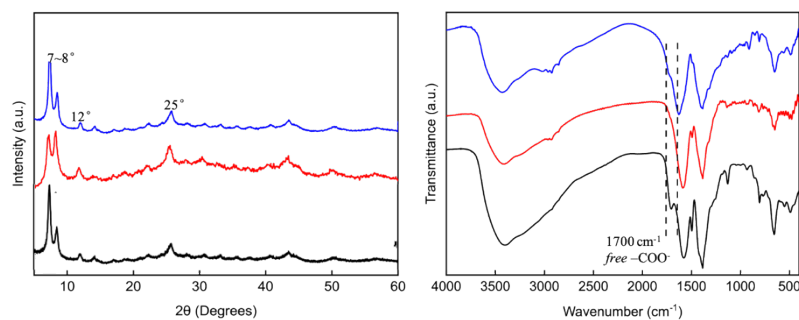
**Fig. S3** Photoluminescent spectra of  $Tb@UiO-66-(COOH)_2$  under different concentrations of  $M^{z+}$  aqueous solution ( $M^{z+} = Ag^+, Co^{2+}, Ni^{2+}, Fe^{3+}, Sn^{4+}$  and  $UO_2^{2+}$ ). The inset is the relationship between the luminescence intensity and corresponding ion concentration at 545 nm.



**Fig. S4** Emission spectra of Tb@UiO-66-(COOH)<sub>2</sub> suspensions after addition of 10<sup>-9</sup> M Ni<sup>2+</sup> (a) and UO<sub>2</sub><sup>2+</sup> (c) at various time intervals and the emission intensity at 544 nm as a function of contact time to Ni<sup>2+</sup> (b) and UO<sub>2</sub><sup>2+</sup> (d).

**Table S1**  $K_{sv}$  value of uranium adsorption by reported Ln-MOFs

MOFs	$K_{sv}$ (M <sup>-1</sup> )	Ref.
[Tb(BPDC) <sub>2</sub> ](CH <sub>3</sub> ) <sub>2</sub> NH <sub>2</sub>	$1.03 \times 10^4$	1
[Eu <sub>2</sub> (MTBC)(OH) <sub>2</sub> (DMF) <sub>3</sub> (H <sub>2</sub> O) <sub>4</sub> ].2DMF.7H <sub>2</sub> O	3631.5	2
[Ln(ox)(L)] <sub>n</sub> (ox = oxalate, HL = <i>N,N'</i> -dipropionic acid imidazolium, Ln = Eu <sup>3+</sup> )	$6.19 \times 10^4$	3
(CH <sub>3</sub> ) <sub>2</sub> NH <sub>2</sub> [Ln <sub>2</sub> (BTC)(AC) <sub>3</sub> (FM)] (H <sub>3</sub> BTC=1,3,5-benzenetricarboxylic acid)	$8.56 \times 10^3$	4
Tb@UiO-66-(COOH) <sub>2</sub>	$5.994 \times 10^7$	This work



**Fig. S5** The PXRD patterns and FTIR spectra of the Tb@UiO-66-(COOH)<sub>2</sub> (black), Tb@UiO-66-(COOH)<sub>2</sub> treated with Ni<sup>2+</sup> (red) and UO<sub>2</sub><sup>2+</sup> (blue).

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