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"Turn-on" fluorescent sensor for Th^{4+} in aqueous media based on a combination of PET-AIE effect

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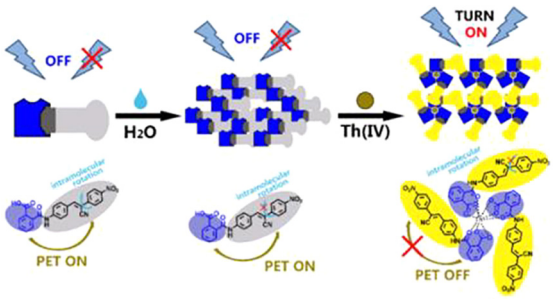
HIGHLIGHTS

- The first turn-on fluorescence probe for Th^{4+} in aqueous media was reported.
- The detection limit for Th^{4+} was as low as 0.074 μM.
- It was applied to detect Th^{4+} on TLC plates and in real water samples.
- It displayed excellent living-cell imaging property for tracing Th^{4+}.
- The detecting mechanism of AIE-PET effect was confirmed.

GRAPHICAL ABSTRACT

The first "turn-on" fluorescent sensor for Th^{4+} in aqueous media was achieved.



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ABSTRACT

Previously reported fluorescent sensors for Th^{4+} experienced emission quenching or generated false positive signal upon aggregate formation in aqueous media. Herein, a simple and novel thorium sensor (**CDB-BA**) based on cyanodistyrene structure was designed and synthesized, which integrated the highly emitting characteristic of AIE effect and off-on response of PET modulation for the first time to construct the "turn-on" fluorescent probe for Th^{4+}. Besides excellent selectivity, **CDB-BA** exhibited remarkable fluorescent enhancement which was linearly related to the concentration of Th^{4+} in the range of 0.25–8 μM. The detection limit was attained 0.074 μM, which was lower than that of most previously reported sensors. The mechanism of tris-chelate complex of **CDB-BA** with Th^{4+} was confirmed by mass spectra, IR spectra and DFT calculation. The excellent Th^{4+} sensing ability of **CDB-BA** was successfully applied to detecting Th^{4+} on TLC plates, in real water samples and living-cell imaging. This work suggested that the combination of AIE and PET photophysical mechanism could offer the merits of minimized background and enhanced signal fidelity to develop novel "turn-on" fluorescent probe in complicated aqueous environment and biological research.

1. Introduction

Thorium, a long-lived radionuclide, is very hazardous to human health and environment due to both its radiological and chemical toxicity [1–5]. Used as a X-ray contrast agent in the 1930s–1950s, ThO_2 was initially believed to have no side effects but was

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