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A Molecular Probe for Cisplatin Detection Based on Fluorescence Resonance Energy Transfer

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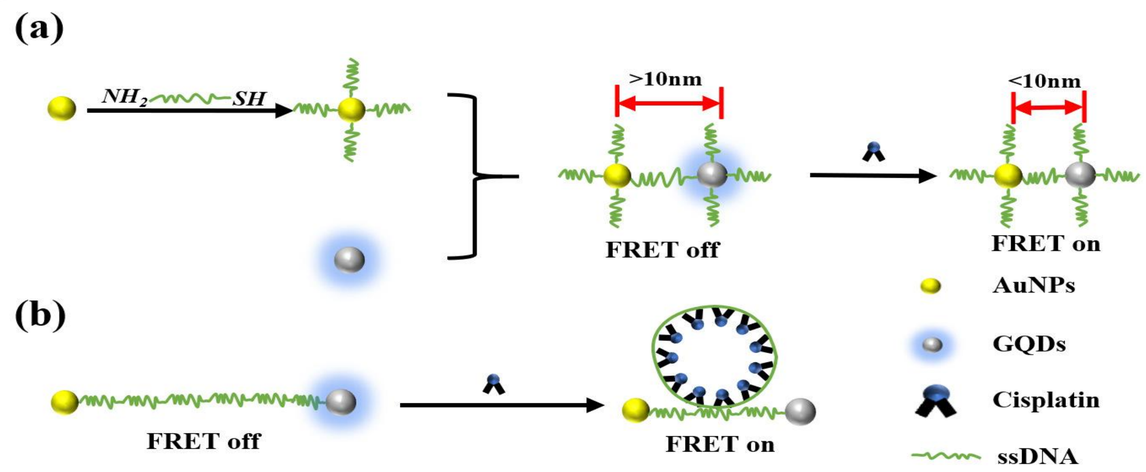
Background

- Cisplatin is one of the most widely used chemotherapeutic medications, individual disparities in metabolic capabilities of cisplatin amongst patients are noticeable.
- Existing approaches for Cisplatin Detection are expensive with advanced analytical instruments, and require extensive sample pre-treatment, which cannot meet the demand for clinical sample detection.
- FRET-based approaches for detecting heavy metal ions, small molecules and organic macromolecules have attracted considerable interests due to their simplicity, low cost, high sensitivity and selectivity.

Methods & Results

Design Principle of FRET molecular probes



- The AuNPs were modified with ssDNA strand by **the freezing method**.
- The GQDs were linked to ssDNA-AuNPs by 1 - Ethyl - 3 - (3 - dimethyl aminopropyl) carbodiimide (EDC), thus forming the FRET molecular probes **("FRET off")**.
- The addition of cisplatin will **shorten the distance** between GQDs and AuNPs, a relatively significant FRET effect was formed **("FRET on")**.

Fig. 1. (a) Design principle of cisplatin detection based on FRET molecular probe; (b) Schematic illustration of cisplatin interaction with ssDNA leads to FRET effects between GQDs and AuNPs.

Morphological characterization

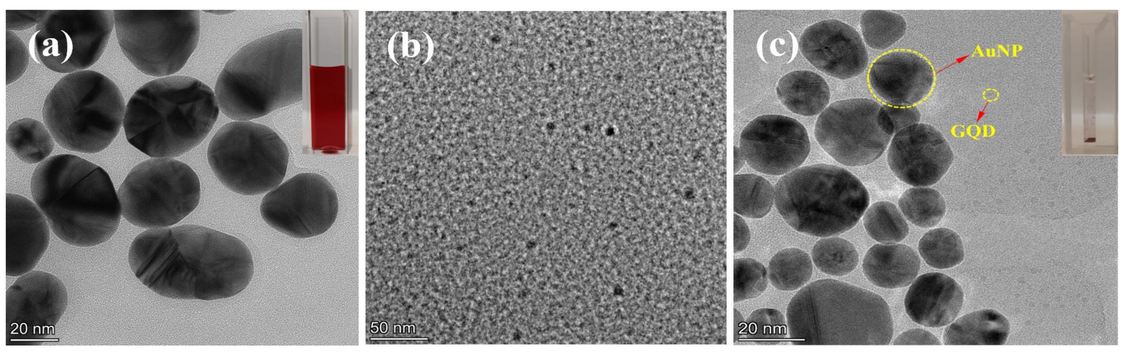


Fig. 2. TEM images of (a) synthesized AuNPs with average size of 17.1 nm. Scale bar: 20 nm; (b) GQDs with average size of 5 nm. Scale bar: 50 nm; (c) FRET molecular probe. Scale bar: 20 nm.

Spectral characterization

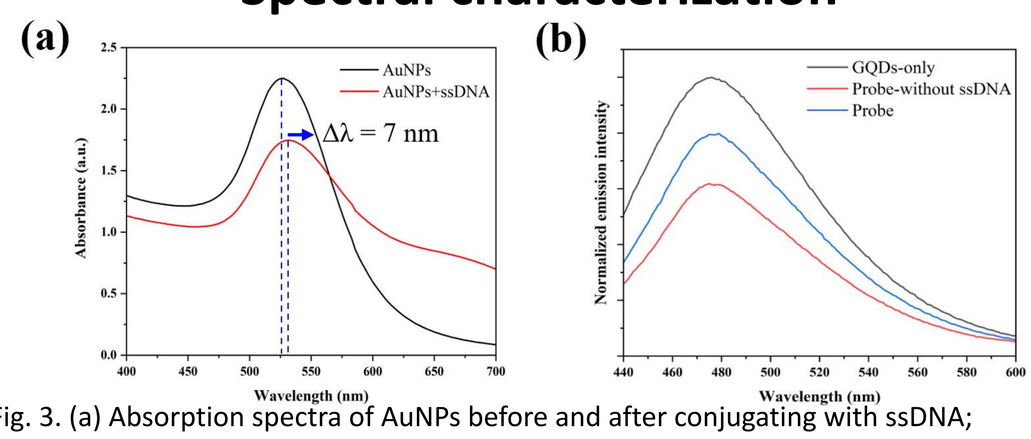


Fig. 3. (a) Absorption spectra of AuNPs before and after conjugating with ssDNA; (b) Fluorescence emission spectra of GQDs, FRET molecular probe and simple hybrid solutions of AuNPs and GQDs in the absence of ssDNA.

Quantitative model for cisplatin detection

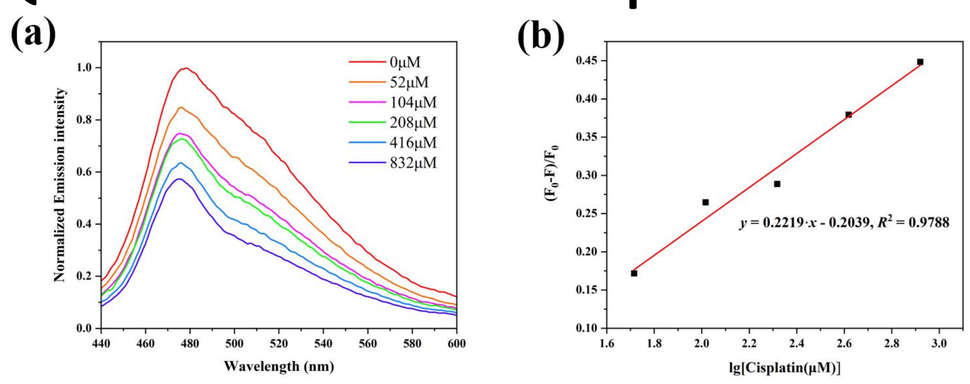


Fig. 4. (a) Fluorescence emission spectra of the FRET molecular probe after adding various concentrations of dechlorinated cisplatin (from top to bottom: 0, 52, 104, 208, 416 and 832 μM); (b) Plot of the relative reduction of the fluorescence signal ($F_0 - F$) /F_0 versus a series of dechlorinated cisplatin concentrations from 52-832 μM.

The specificity of molecular probes

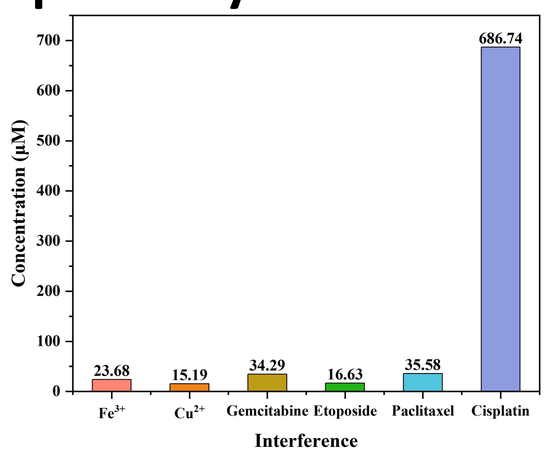


Fig. 5. Specificity of the FRET molecular probe in presence of Fe^{3+}, Cu^{2+}, gemcitabine, etoposide, paclitaxel and cisplatin (832 μM).

Conclusions & Prospects

- A FRET-based fluorescence molecular probe for detecting active cisplatin has been demonstrated.
- The proposed quantitative model has a cisplatin detection range of 52-832 μM, and the additional experiment validated the specificity of the molecular probe.
- By continuously optimizing the structure of FRET molecular probe and its corresponding detection conditions, the detection range will be extended to low concentrations for better application in the detection of serum active cisplatin in patient samples.

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