

## Nanozyme-based dual-mode DNA biosensor for self-powered sensitive detection of Sulfate-reducing bacteria

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**Abstract** Sulfate-reducing bacteria (SRB) were recognized as significant contributors to microbiologically induced corrosion (MIC). Developing effective, economical, sensitive, and specific detection methods for SRB was crucial for understanding microbial corrosion mechanisms and for early monitoring. In this paper, a novel dual-mode biosensor was successfully constructed for detecting the DsrA gene associated with SRB. The biosensor utilized gold nanoparticles (AuNPs) as nanoenzymes and methylene blue (MB) as an electron acceptor, enabling electrochemical and colorimetric self-powered detection. The AuNPs/Cu-TCPP(Fe) composites were synthesized using a hydrothermal method and characterized through various techniques, including SEM, TEM, XRD, FT-IR, UV-Vis, and XPS, to verify morphology, structure, and composition. Nanozyme activity experiments demonstrated the glucose oxidase-like activity of the material. Characterization of the modification processes for the anode with the composite material and the cathode with DNA nanostructures was performed using CV, LSV, DPV, and EIS techniques to evaluate the electrochemical behaviors. Under optimized conditions, open circuit potential and RGB Blue values were employed as signal responses for the electrochemical and colorimetric modes, respectively. Compared to previously reported sensors for SRB DNA detection, this biosensor demonstrated superior detection performance with stability, specificity, and reproducibility. Notably, the biosensor achieved a detection range in the target concentration of 1 fM to 10 nM, with detection limits at 0.33 fM in electrochemical mode and 0.41 fM in colorimetric mode. Additionally, the biosensor effectively detected extracted SRB DsrA gene fragments from real seawater samples, showing a broader detection range and lower detection limits compared to traditional methods such as agarose gel electrophoresis and real-time fluorescence PCR. In conclusion, this dual-mode self-powered biosensor provided a promising alternative for sensitive and specific detection of SRB, highlighting its potential practical application value in SRB detection.

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**Keywords** Microbiologically induced corrosion; Sulfate-reducing bacteria; Dual-mode biosensor; DsrA gene; Detection

**Reference**

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