Enhanced electrochemiluminescent aptasensor for mercury based on CdTeSe@CdS QDs-DNA bioconjugates and enzymatic catalysis

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Heavy metals in atmospheric particulate matter emission from coal-fired power plants have attracted global attention. Aiming at the complexity and trace content of mercury, a highly sensitive and selective “signal-on” electrochemiluminescent (ECL) aptasensor was proposed for detection of mercury by using CdTeSe@CdS QDs-DNA bioconjugates and enzyme-catalysis signal amplification strategy. The thiol-modified DNA I (Probe I) was fixed on the gold electrode as the main chain, which reacted with QDs-labeled adapter probe DNA II (Probe II) by thymine-Hg²⁺-thymine (T-Hg²⁺-T) structure in presence of Hg²⁺, resulting in the production of the increased ECL signal of QDs. The biotin-labeled DNA III (Probe III) was paired with Probe I, and streptavidin-horseradish peroxidase (HRP) conjugate integrated to Probe III to enhance the intensity of ECL by enzymatic catalysis. The ECL signal of CdTeSe@CdS QDs-DNA provides quantitative measures of the concentrations of Hg²⁺, with a linear calibration ranging from 1.0×10⁻¹¹ to 1.0×10⁻⁶ M. This ECL aptasensor performed with admirable stability and good selectivity, enabling the detection of mercury at a very low limit (3.5×10⁻¹² M) and negligible for other interfering metal ions. The results suggested that this method is feasible and widely used to determine mercury in atmospheric particulate matter (such as fly ash), as well as the other heavy metals in the environment.

Keywords: electrochemiluminescence; aptasensor; mercury; enzymatic catalysis; quantum dots; fly ash.

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