A supramolecular nanobiological hybrid as a PET sensor for bacterial DNA isolated from *Streptomyces sanglieri*†

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The development of a rapid, label free, cost effective and highly efficient sensor for DNA detection is of great importance in disease diagnosis. Herein, we have reported a new hybrid fluorescent probe based on a cationic curcumin–tryptophan complex and water soluble mercapto succinic acid (MSA) capped CdTe quantum dots (QDs) for the detection of double stranded DNA (ds DNA) molecules. The cationic curcumin–tryptophan complex (CT) directly interacts with negatively charged MSA capped quantum dots via electrostatic coordination, resulting in photoluminescence (PL) quenching of QDs via the Photoinduced Electron Transfer (PET) process. Further, addition of ds DNA results in restoration of PL as CT would intercalate between DNA strands. Thus, this process can be utilized for selective sensing of ds DNA via fluorescence measurements. Under optimized experimental conditions, the PL quenching efficiency of QDs is found to be 99.4% in the presence of 0.31 × 10⁻⁹ M CT. Interestingly, the regain in PL intensity of QD–CT is found to be 99.28% in the presence of 1 × 10⁻⁸ M ds DNA. The detection limit for ds DNA with the developed sensing probe is 1.4 × 10⁻¹⁰ M. Furthermore, the probe is found to be highly sensitive towards bacterial DNA isolated from *Streptomyces sanglieri* with a detection limit of 1.7 × 10⁻⁹ M. The present work will provide a new insight into preparation of bio-inspired hybrid materials as efficient sensors for disease diagnosis and agricultural development.

Introduction

The design of simple, rapid, sensitive and cost effective fluorescent probes for DNA detection plays a vital role in clinical diagnosis, preventive care and drug discovery. Such probes are based on small molecule–DNA interactions including electrostatic interactions or intercalation or groove binding. Previous organic fluorophores were used as probes for DNA sensing. However, traditional fluorescent probes suffer from certain limitations such as long term photostability, short PL lifetime, wide PL spectra and solubility. So, organic fluorescent probes can be merged with highly luminescent semiconductor QDs for superior properties. Such QDs are nanocrystals exhibiting unique optical properties like tunable emission spectra, improved brightness, superior photostability and simultaneous excitation of multiple fluorescence colours. There are many strategies available for DNA detection. Fluorescence Resonance Energy Transfer (FRET) represents one of the most widely used tools for DNA detection in a homogeneous solution. But, this requires dual labelling of the probe molecule with two spectroscopic-distinguishable fluorophores or a fluorophore–quencher pair, which is time consuming, expensive and have poor detection limits. But for such purposes, the photoinduced electron transfer (PET) process is advantageous. However, there are only a few reports available which explain the significance of the electron transfer mechanism. Raymo et al. developed a photoinduced electron transfer (PET) based sensor for signal receptor–substrate interactions. Also, Vaishnavi et al. reported a PET based sensor using a quantum dot-cationic porphyrin nanohybrid.

In our present work, we have reported a highly efficient label free sensor for ds DNA using cationic curcumin–tryptophan (CT) and MSA capped CdTe QDs, thus merging together the properties of both organic and inorganic materials. Also, the sensing of bacterial DNA isolated from *Streptomyces sanglieri* with our probe has been studied. CT has been synthesized by