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DNA-embedding Schiff base molecule assemblies: an efficient biological detection approach based on clustering-triggered emission†

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In this study, we prepared novel hybrid assemblies composed of a small Schiff base molecule, (*E*)-1-(4-(dimethylamino)-phenyl)imino-methyl-2-hydroxyl-naphthalene (DPIN), and single strand DNAs (ssDNAs). Owing to clustering-triggered emission (CTE), aggregated hybrid assemblies emit a strong fluorescence signal. However, after incubation with specific target DNA (tDNA) sequences, the formed double helical DNAs dispersed the hybrid assemblies and contributed to the decrease in the fluorescence signal. By contrast, the cases of 1-mer and random mismatched tDNA sequences did not show any such diminished fluorescence signal.

Introduction

Since the booming development of materials chemistry in the past 20–30 years, perhaps the most noteworthy is the combination with nanotechnology.[1–3] Taking this as an opportunity, many theoretical and applied researches related to nanomaterials have achieved a blowout development.[4–7] Owing to their biocompatibility, specific surface, chemical stability, and innocuous nature, a variety of nanomaterials have been suggested as potential candidates for DNA sensing.[8–10] Among them, fluorescent DNA nanosensors have obtained significant attention owing to their advantages of high sensitivity, convenient operation, and low signal-to-noise ratio. In general, probe DNA (pDNA) molecules acting as recognition elements are conjugated with the fluorescent nanomaterials and therefore made to form a hybrid specifically with the complementary target DNA (tDNA) molecules.[11,12] A subsequent change in the fluorescence of the nanomaterial is then measured; there are various mechanisms for the change in fluorescence properties of nanomaterials caused by DNA hybridization.[13–15] For example, approaches based on the conformational change of π-conjugated polymers upon DNA hybridization have been developed by numerous scholars.[16–18]

Recently, the hybrid assemblies composed of an organic semiconducting molecule, tri(8-hydroxyquinoline) aluminum (Alq_3), and single-strand DNAs (ssDNAs) prepared by Ahn and co-workers were proven to recognize specific tDNA molecules.[19,20]

Recently it was found that Schiff base compounds, a class of organic small molecules, exhibit excellent performance in the sensing of metal ions, anions, thiols, nitrogen-containing compounds, pH change, and bacteria.[21–26] The sensing mechanism of these substances can be explained by the well-known aggregation-induced emission (AIE) phenomenon displayed by Schiff base compounds.[27,28] It is customary to think that the C=N isomerization process is inhibited, and a great fluorescence enhancement phenomenon is exhibited. Hence, more precisely, the enhanced fluorescence signals of the Schiff base molecules, in which there is no conventional chromophore, can be explained by the clustering-triggered emission (CTE).[29]

Herein, we report a simple self-assembly growth of a small Schiff base molecule, (*E*)-1-(4-(dimethylamino)- phenyl)imino-methyl-2-hydroxyl-naphthalene (DPIN), in ssDNA solution to prepare rod-shaped hybrid assemblies. Owing to hydrogen bonds and electrostatic and hydrophobic interaction between the hybrid assemblies, aggregated hybrid assemblies emit strong fluorescence signals induced by CTE. However, after incubation with specific tDNA sequences, the formed double-helical DNA greatly enhanced the repulsive force between the hybrid assemblies, accompanied by a weakening of the fluorescence signal. To the best of our knowledge, the DNA detection method developed in this study is currently the simplest method based on CTE. DPIN–ssDNA hybrid assemblies studied here can be extended to apply in effective DNA or other biomolecule sensors owing to their simple fabrication, specificity, and

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