Aptamer-Based Fluorescent Biosensing of Adenosine Triphosphate and Cytochrome *c* via Aggregation-Induced Emission Enhancement on Novel Label-Free DNA-Capped Silver Nanoclusters/Graphene Oxide Nanohybrids

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Abstract

Four fluorescent DNA-stabilized fluorescent silver nanoclusters (DNA–AgNCs) were designed and synthesized with differences in lengths of cytosine-rich DNA strand (as the stabilizing agent) and target-specific strand DNA aptamers for adenosine triphosphate (ATP) and cytochrome *c* (Cyt *c*). After their nanohybrid formation with graphene oxide (GO), it was unexpectedly found that, depending on the composition of the base and length of the strand DNA aptamer, the fluorescence intensity of three of the nanohybrids significantly enhanced. Our experimental observations and quantum mechanical calculations provided an insight into the mechanisms underlying the behavior of DNA–AgNCs/GO nanohybrids. The enhanced fluorescence was found to be attributed to the aggregation-induced emission enhancement (AIE) characteristic of the DNA–AgNCs adsorbed on the GO surface, as confirmed evidently by both fluorescence and transmission electron microscopies. The AIE is a result of hardness and oxidation properties of GO, which lead to enhanced argenophilic interaction and thus to increased Ag(I)–DNA complex shell aggregation. Consequently, two of the DNA–AgNCs/GO nanohybrids were successfully extended to construct highly selective, sensitive, label-free, and simple aptasensors for biosensing of ATP (LOD = 0.42 nM) and Cyt *c* (LOD = 2.3 nM) in lysed *Escherichia coli* DH5 α cells and mouse embryonic stem cells, respectively. These fundamental findings are expected to significantly influence the designing and engineering of new AgNCs/GO-based AIE biosensors.

KEYWORDS:

- nanoclusters
- fluorescence
- aggregation-induced emission enhancement
- cytochrome *c*
- adenosine triphosphate