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Facile and room temperature synthesis of highly red emittive gold nanodots for the application in paper based chemosensor of toxic anions

Abstract

For the past few decades, fluorescent gold nanomaterials have gained momentum due to their fascinating physical and chemical properties. Generally, researchers are using proteins, peptides, dendrimers, DNA or high molecular weight polymers as templates for the synthesis of gold nanoclusters (AuNCs) and gold nanodots (AuNDs) [1]. These methods typically need long reaction times between 10-72 hours at 37°C and the reaction has often to be performed in the absence of light [2]. Thus, synthesis of AuNCs and AuNDs are tedious and time consuming, and the development of a simple and one step and room temperature synthesis of nanomaterials with high red fluorescence is an essential for their subsequent application in sensing, tumor therapy, bioimaging etc., [1]. Currently, there are no reports available in the literature for one-pot rapid, facile and room temperature synthesis of high red emittive gold nanomaterials at room temperature and using a simple heterocyclic ligands as templates.

On the other hand, the detection of anions such as cyanide, fluoride, sulfide and nitrite etc., in environmental water by paper based sensor are of significant interest [3]. In particular cyanide and sulfides are highly toxic and a threat to the environment.

This presentation emphasis the simple and one-pot synthesis of trithiocyanuric acid (TCA) or mercapto functionalized triazolo-tetrazine (MTT) capped TCA-AuNDs and MTT-AuNDs, respectively, for their use in the specific detection of cyanide and sulfide ions in environmental water samples. TCA and MTT act as capping surface ligands, providing good solubility in aqueous medium, and as mild reducing agents. Additionally, the TCA capped AuNDs surface has been coated with polyethylene glycol (PEG) to provide biocompatibility and a universal and well-known chemistry to further perform conjugation to different biomolecules, which would allow the use of the synthesized AuNDs in other applications.

Our new synthesis protocol of TCA-AuNDs and MTT-AuNDs does not require the use of proteins, peptides, or high molecular weight polymers or other reducing agents including tetrakis(hydroxymethyl)phosphonium chloride (THCP) or $NaBH_4$ [4,5]. To the best of our knowledge, this is the first AuNDs synthesis that is completed within 10 minutes at room temperature. The obtained TCA-AuNDs and MTT-AuNDs have been successfully evaluated as highly sensitive and selective cyanide and sulfide sensing probes, respectively. We have applied those AuNDs to detect cyanide and sulfide in real water samples including tap, river, lake and sea water. Further, we have demonstrated that the descried detection can be implemented in paper based sensors for cyanide and sulfide.

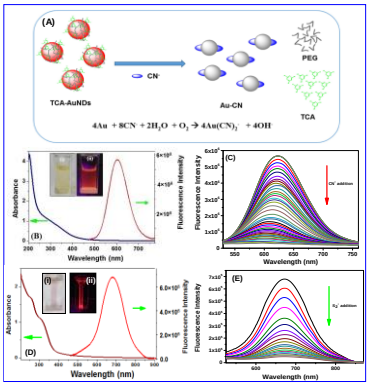

Figure 1. (A) Scheme of mechanism elucidation of the interaction of CN^- with PEG coated TCA-AuNDs. (B) Absorption and emission spectra of TCA-AuNDs. *Inset of A:* Photographs of TCA-AuNDs under (i) day light and (ii) UV light. (C) Emission spectra of TCA-AuNDs with different concentration of CN^-. (D) Absorption and emission spectra of MTT-AuNDs. *Inset of A:* Photographs of MTT-AuNDs under (i) day light and (ii) UV light. (E) Emission spectra of MTT-AuNDs with different concentration of S_2^-.

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