Sensitive Visual Detection of Uranyl based on Ratiometric Fluorescence of Nanocomposite

Xinfeng Chen[1], Khalid A. Alamry[2], Hadi M. Marwani[2], Suhua Wang[1,2,3]

[1]*School of Environment and Chemical Engineering, North China Electric Power University, Changping, Beijing 102206, China. Email: wangsuhua@nceupu.edu.cn*
[2]*Chemistry Department, Faculty of Science, King Abdulaziz University, Jeddah 21589, Saudi Arabia. Email: aasiri2@kau.edu.sa*
[3]*Institute of Intelligent Machines, Chinese Academy of Sciences, Hefei, Anhui 230031, China*.

I. INTRODUCTION

The uranyl ions are toxic to environment and health, so it is of significant to develop novel method to detect and monitor its contamination levels.[1] Among various analytical techniques, the fluorescence-based methods generally have excellent sensitivity and high selectivity for identifying trace amounts of analyte.[2] In addition, the change of fluorescent color is capable of revealing the presence of an analyte in a more conceivable way.[3,4] Herein, we hybridized highly fluorescent graphene oxide with quantum dots (QDs) and examined its potential to build a novel nanohybrid for uranyl detection based on ratiometric fluorescence strategy.

I.A. RESULTS

In order to detect uranyl on the basis of ratiometric fluorescence, we have synthesized fluorescent graphene oxide with stable fluorescence and red fluorescent quantum dots with surface functions. The graphene oxide was modified with amine compound for stable fluorescence and various surface functions in order to hybridize with quantum dots. The red-emissive dithiothreitol-functionalized quantum dots were functionalized to be specific to uranyl. The two components have been hybridized through surface reaction and interaction to form a dual-emissive nanostructure. It has been found that the two different emissions from graphene oxide and quantum dots respond to uranyl ions in a very different way. The graphene oxide is very inert to uranyl ions and its fluorescence keeps stable when exposed, however, the quantum dots with functional can selectively react to uranyl and its red fluorescence can be greatly quenched. The two different responses to uranyl generate a composite flourescence color change from bright orange to blue. We thus applied the new nanohybrid of graphene oxide and quantum dots for the selective and sensitive measurement of uranyl ions by recording the fluorescence intensity ratios. To evaluate its practical application, the nanohybrid has been doped in a polymer film to make a test strip for on-site and visual determination of uranyl. It has been shown that a visual detection limit of 0.12 μM for the film strip has been found, and the potential application for on-site visual and rapid determination of uranyl ions.

II. CONCLUSIONS

We have demonstrated a novel analytical and measurement method for uranyl ions by employing fluorescence graphene oxide and quantum dots. The graphene oxide is used as a reliable internal reference and the quantum dots is used as the reporter for the analyte target. The integrated nanohybrid significantly enhanced the sensitivity and improved the reliability for visual detection of uranyl ions. The nanohybrid has further been utilized to fabricate a portable film sensor for rapid visual detection of uranyl ions in real water samples.

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