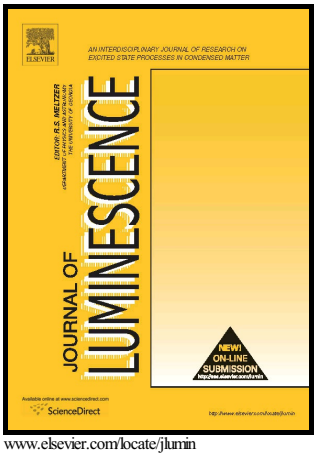
Selective and sensitive detection of copper(II) based on fluorescent zinc-doped $AgInS_2$ quantum dots

Yongfeng Liu, Tao Zhu, Ming Deng, Xiaosheng Tang, Shuai Han, Anping Liu, Yongzhong Bai, Dingrong Qu, Xianbin Huang, Feng Qiu



www.elsevier.com/locate/jlumin

PII: S0022-2313(18)30110-8
DOI: https://doi.org/10.1016/j.jlumin.2018.04.046
Reference: LUMIN15561

To appear in: *Journal of Luminescence*

Received date: 21 January 2018
Revised date: 27 March 2018
Accepted date: 21 April 2018

Cite this article as: Yongfeng Liu, Tao Zhu, Ming Deng, Xiaosheng Tang, Shuai Han, Anping Liu, Yongzhong Bai, Dingrong Qu, Xianbin Huang and Feng Qiu, Selective and sensitive detection of copper(II) based on fluorescent zinc-doped $AgInS_2$ quantum dots, *Journal of Luminescence,* https://doi.org/10.1016/j.jlumin.2018.04.046

Selective and sensitive detection of copper(II) based on fluorescent zinc-doped $AgInS_2$ quantum dots

Yongfeng Liu[a], Tao Zhu*[a], Ming Deng[a], Xiaosheng Tang[a], Shuai Han[a], Anping Liu[b], Yongzhong Bai[c], Dingrong Qu[c], Xianbin Huang[c], Feng Qiu[c]

[a] Key Laboratory of Optoelectronic Technology & Systems of the Education Ministry of China, College of Optoelectronic Engineering, Chongqing University, Chongqing 400044, China

[b] Institute for Structure and Function, Chongqing University, Chongqing 401331, China

[c] State Key Laboratory of Safety and Control for Chemicals, SINOPEC Research Institute of Safety Engineering, Qingdao 266000, China

*Corresponding author. Tel.: +8623-65111973; Fax: +8623-65111973. E-mail address: zhutao@cqu.edu.cn.

Abstract: Sensitive and selective strategies for the rapid detection of hazardous heavy metal ions in aqueous solution are of great significance. In this study, hydrophobic zinc-doped $AgInS_2$ (AIZS) quantum dots (QDs) are synthesized by hot-injection method, and then transferred into water-dispersible by sodium dodecyl sulfate (SDS) via mini-emulsion/solvent evaporation technique. The as-prepared hydrophilic AIZS QDs are successfully applied for the detection of divalent copper ions in water. The photoluminescence (PL) of the hydrophilic AIZS QDs is quenched by Cu^{2+} ions, which could be contributed to effective electron transfer from QDs to Cu^{2+}, as verified by corresponding X-ray photoelectron spectroscopy (XPS). The probe possesses low relative standard deviation of 2.1% and wide linear range from 0 to 340 μM with a limit of detection (LOD) as low as 27.3 nM. What's more, the sensing system is not interfered by other cations, indicating its good selectivity toward Cu^{2+}. The QDs-based fluorescent sensor possesses greatly practical potential to determine the concentration of copper(II) in drinking water and natural water resources.

Keywords: Zinc doped $AgInS_2$ quantum dots; Fluorescence probe; Copper(II) detection; quenching.

1. Introduction

Contaminations caused by heavy metal ions pose serious threats to environment and even human health due to their high toxicity, carcinogenic effects, easy mobility, and ability of accumulation in ecosystem and human body [1–3]. Particularly, Cu^{2+}, one of the most common heavy metals and essential to humans, plays important roles in various biological process such as being a catalyst for heme synthesis and iron absorption, but on the other hand, excess Cu^{2+} can exert many adverse effects on humans including gastrointestinal disturbance, liver or kidney damage, and neurodegenerative diseases [4–6]. In recent years, it has been suspected of being the murderer causing the liver damage in infants [6, 7]. Considering such negative effects, the Chinese Ministry of Health (CMH), U.S. Environment Protection Agency (EPA), and World Health Organization (WHO) regulate maximum permissible levels of copper (II) of less than 15 μM [8], 20 μM [9], and 31 μM in water [10], respectively. Therefore, quantitative determination of Cu^{2+} concentration in environmental and drinking water is still of great significance. The traditional methods for accurate determination of copper concentration in the environment and biological samples, such as anodic stripping voltammetry (NSV) [11], atomic absorption spectrophotometry (AAS) [12], and inductively coupled plasma-mass spectrometry