Spectrochimica Acta Part A: Molecular and Biomolecular Spectroscopy 120 (2014) 646–649

Contents lists available at ScienceDirect

Spectrochimica Acta Part A: Molecular and Biomolecular Spectroscopy

journal homepage: www.elsevier.com/locate/saa

Short Communication

Spectral properties of highly selective chemosensor for Hg^{2+} ☆

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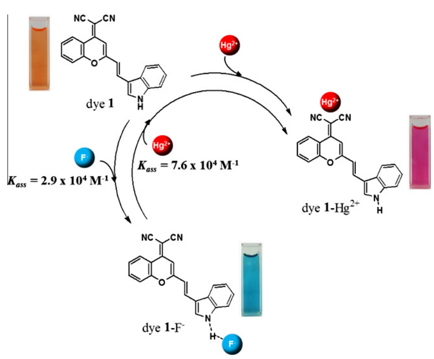
HIGHLIGHTS

- Dye **1** was synthesized and its cation sensing properties were investigated.
- The dye **1** exhibited high selectivity for Hg^{2+} as compared with other cations.
- Dye **1**-F^- complex also could be recovered by adding Hg^{2+}.

GRAPHICAL ABSTRACT



ARTICLE INFO

Article history:
Received 21 June 2013
Received in revised form 11 October 2013
Accepted 17 October 2013
Available online 25 October 2013

Keywords:
Chemosensor
Hg^{2+} cation sensing
Fluoride ion
Colorimetric
Association constant

ABSTRACT

A (*E*)-2-(2-(2-(1H-indol-3-yl)vinyl)-4H-chromen-4-ylidene)malononitrile (dye **1**) was synthesized and its cation sensing properties in DMSO were investigated by UV–vis spectroscopy. Upon the addition of Hg^{2+}, the solution of dye **1** showed color change and the absorption band shows a formation of a 1:1 dye **1**-Hg^{2+} coordination complex. The dye **1** exhibited high selectivity for Hg^{2+} as compared with other cations. Interestingly, the dye **1**-F^- complex also could be recovered by adding Hg^{2+}. We have investigated the ability of complex formation based on the association constant, K_{ass}; the binding ability for the complex formation of dye **1**-F^- and Hg^{2+} is greater than that of the dye **1** with F^-.

Introduction

Chemosensor is a topic of considerable interest because of their importance in specific detection of analytes in various fields such as chemistry, biology, medicine, and environmental studies [1], so much attention has been focused on the development of chemosensors for the selective and efficient detection of biologically and chemically important ions.

In particular, heavy metal cations are of concern, not only among the scientific community, especially chemists, biologists, and environmentalists, but increasingly among the general population, who are aware of the some of the disadvantages associated with them [2]. In spite of the fact that some heavy metal cations play important roles in living systems, they are very toxic and hence capable of causing serious environmental and health problems [3–8]. Especially, mercury cation (Hg^{2+}) is deadly toxic to humans by causing cell dysfunction, which consequently leads to many health problems such as central nervous system defects

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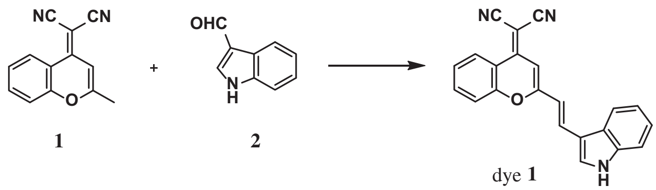
http://dx.doi.org/10.1016/j.saa.2013.10.061



Scheme 1. Synthesis of dye **1**.

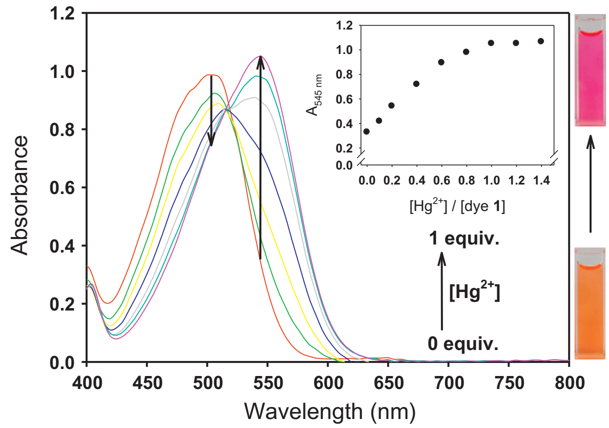


Fig. 1. Changes in UV–vis spectra of dye **1** (2×10^{-5} mol L^{-1} in DMSO) upon addition of Hg^{2+}.

and erethism as well as arrhythmia, cardiomyopathy, and kidney damage [9,10].

Various organic dye-based sensors have been studied as a chemosensor [11–19]. We also have reported the synthesis and metal ion detection properties of dyes [20–30]. On the basis of these previous reports, we are continuously exploring the synthesis and properties of new dyes, which can potentially yield a new class of chromogens for the selective and quantitative detection of ions, both for biological and environmental applications. Recently, we have reported the synthesis and binding properties of dye **1** chemosensor which exhibited high selectivity for fluoride anion (F^-) [31]. In this paper, we report about cation sensing properties of dye **1** chemosensor which shows highly selective detection of Hg^{2+} among the various cations.

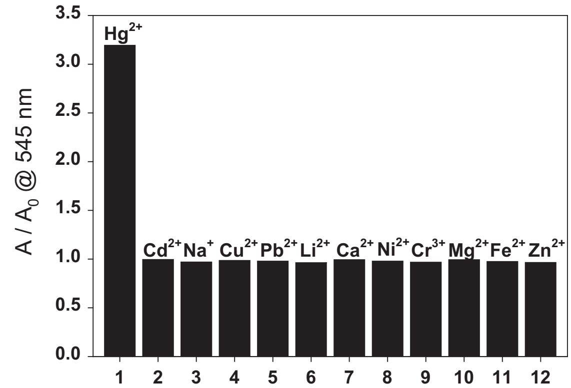


Fig. 3. Comparison of absorption ratio for various cations (A and A_o are the absorbance in the presence and the absence of cations at 545 nm). From left to right: 1, Hg^{2+}; 2, Cd^{2+}; 3, Na^{+}; 4, Cu^{2+}; 5, Pb^{2+}; 6, Li^{2+}; 7, Ca^{2+}; 8, Ni^{2+}; 9, Cr^{3+}; 10, Mg^{2+}; 11, Fe^{2+}; 12, Zn^{2+}.

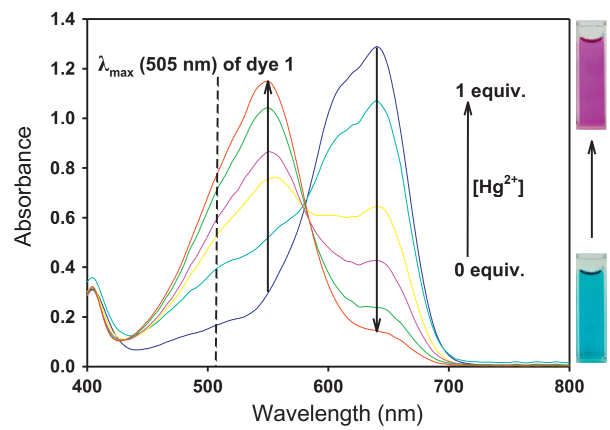


Fig. 4. Changes in UV–vis spectra of dye **1**-F^- (2×10^{-5} mol L^{-1} in DMSO) upon addition of Hg^{2+}, —; dye **1** (λ_{max}: 505 nm).

Experimental

The dye **1** was synthesized according to previously described procedures [31]. Stock solution of the cations (1×10^{-4} mol L^{-1}) was prepared in DMSO; a stock solution of dye **1** (1×10^{-4} mol L^{-1}) was prepared in DMSO. Mixtures were made, in which a 1 ml aliquot of the stock dye **1** solution (2×10^{-5} mol L^{-1} dye **1**

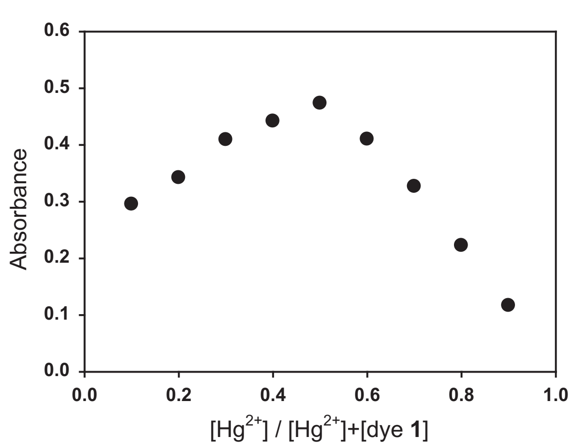


Fig. 2. Job's plot of Hg^{2+} versus dye **3** ([Hg^{2+}] + [dye **1**] = 2×10^{-5} mol L^{-1}).

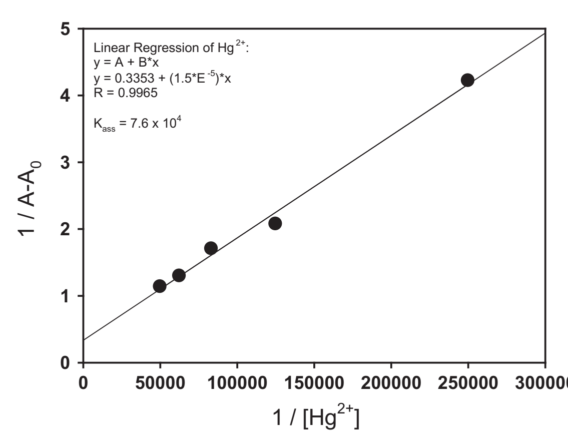


Fig. 5. Benesi–Hildebrand plots of dye **1** with Hg^{2+} (λ_{max} = 545 nm).