Water Soluble Cationic Porphyrin Sensor for Detection of Hg$^{2+}$, Pb$^{2+}$, Cd$^{2+}$, and Cu$^{2+}$

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ABSTRACT

Here we report the sensing properties of the aqueous solution of meso-tetra(N-methyl-4-pyridyl)porphine tetrachloride (1) for simultaneous detection of toxic metal ions by using UV-vis spectroscopy. Cationic porphyrin 1 displayed different electronic absorptions in UV-vis region upon interacting with Hg$^{2+}$, Pb$^{2+}$, Cd$^{2+}$, and Cu$^{2+}$ ions in neutral water solution at room temperature. Quite interestingly, the porphyrin 1 showed that it can function as a single optical chemical sensor and/or metal ion receptor capable of detecting two or more toxic metal ions, particularly, Hg$^{2+}$, Pb$^{2+}$, and Cd$^{2+}$ ions coexisting in a water sample. Porphyrin 1 in an aqueous solution provides a unique UV-vis sensing system for the determination of Cd$^{2+}$ in the presence of larger metal ions such as Hg$^{2+}$, or Pb$^{2+}$. Finally, the examination of the sensing properties of 1 demonstrated that it can operate as a Cu$^{2+}$ ion selective sensor via metal displacement from the 1-Hg$^{2+}$, 1-Pb$^{2+}$, and 1-Cd$^{2+}$.

RESULTS

INTRODUCTION

Toxic metal ions are dangerous to human health and environment.

Determination of metal ions, particularly, Hg$^{2+}$, Pb$^{2+}$, Cu$^{2+}$, and Cd$^{2+}$ simultaneously by using an inexpensive, water soluble porphyrin based optical sensor has always been a great challenge.

In addition, the preparation of porphyrin-based optical sensors often requires complex organic syntheses, which are very costly, and time consuming.

Furthermore, the porphyrin-based sensors are water insoluble, which limits the detection of metal ions in aquatic environment.

PURPOSE

To find a simple, inexpensive, water soluble, and commercially available porphyrin

a single optical chemical sensor capable of detecting any or all Hg$^{2+}$, Pb$^{2+}$, Cu$^{2+}$, and Cd$^{2+}$ ions simultaneously

FUTURE PLAN

Preparation of solid sensor 1

Determination of toxic metal ions in aqueous solution using solid sensor 1

CONCLUSIONS

We found water soluble, inexpensive, and commercially available cationic porphyrin 1 produced different electronic absorptions in UV-vis region upon interacting with Hg$^{2+}$, Pb$^{2+}$, Cd$^{2+}$, and Cu$^{2+}$ ions.

The porphyrin 1 showed the ability to detect multiple metal ions, particularly Hg$^{2+}$, Pb$^{2+}$, and Cd$^{2+}$ in aqueous solution.

The porphyrin 1 displayed the ability to determine Cd$^{2+}$ ions more easily when other metal ions with larger ionic radii are present.

The porphyrin 1 detected Cu$^{2+}$ via metal displacement from the 1-Hg$^{2+}$, 1-Pb$^{2+}$, and 1-Cd$^{2+}$.

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