Development of Cellulose-based Sensor and Absorbent for Copper Ion Detection and Recovery

（セルロース基材を用いた銅イオンの検出センサーと回収用吸着材の開発）

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Abstract

Water with excessive amounts of Cu^{2+} is extremely harmful to human health as well as to other animals' biology. Therefore, we developed a user-friendly, low-cost, sensitive and ion-species-selective paper-based sensor to inspect drinking and industrial water for excessive levels, especially for people in developing countries. A dual-function paper-based sensor was simply fabricated by printing quinizarin acetone solution onto the filter paper. In the visible detection, it was observed that the color of the dye on a paper-based sensor changed from yellow to purple, suggesting that the sensor has a function to detect Cu^{2+} in water with a concentration of as low as 2 ppm, which is the maximum amount allowed according to World Health Organization for drinking water. In fluorescence detection, obvious linear relationships were obtained between the surface fluorescence intensity and Cu^{2+} concentration of the water samples, indicating

that the quantitative detection was successfully achieved. Furthermore, the measurement accuracy of Cu^{2+} concentration was proven by comparison with the measurement result of Inductively Coupled Plasma-Optical Emission Spectroscopy. With regards to the reaction condition, pH 7 was the optimum and high temperature promoted the detection reaction. About storage, although color fading by strong ultra-violet light was slightly observed, the protection from light in storage would prevent the photoredox reaction.

Furthermore, a recyclable and biodegradable cellulose-based absorbent functionalized with quinizarin non-covalently was developed for Cu^{2+} recovery. We prepared porous cellulose disks based on the viscose process, reinforced the disks with cellulose nanofiber, and functionalized cellulose disks non-covalently with quinizarin for Cu^{2+} recovery from aqueous solution. The non-covalent modification is based on a quick and simple dip-coating method. And cellulose nanofibers as the reinforcement agent for the cellulose sponge were prepared from bamboo by the aqueous counter collision method, which is a physical process beneficial to maintain the selectivity of quinizarin functionalized cellulose disks. Moreover, the quinizarin functionalized cellulose disks were evaluated in Cu^{2+} adsorption study and the effect of other parameters such as pH and recyclability was assessed as well. As a result, the quinizarin functionalized cellulose disks, which are porous, low-cost, recyclable and biodegradable, show great potential, capacity and recyclability in Cu^{2+} recovery from water.