Detection of Hg ions in contaminated water by optical sensor based on polymeric nano-composite.

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The A novel colorimetric sensor based on TiO2/ poly(acryl amide-co-methylen bis acrylamideco-dithizone) (TiO2/poly(Am-co-MBA-co- DTz)) nanocomposite was synthesized by surface modification of a synthesized TiO2 NPs using vinyl linker, which created a reactive vinyl groups for the polymerization of the Am, MBA and modified dithizone on the surface of modified TiO2 NPs. The prepared polymeric nanocomposite was characterized by Fourier transform infrared spectroscopy (FT-IR), scanning electron microscopy (SEM), there mogravimetric analysis (TGA) and X-ray powder diffraction (XRD). A fast, selective and inexpensive screening-test for recognizing Hg ions contamination in aqueous solution is described to avoid time-consuming and costly determination using atomic absorption spectrometry. This nanostructured composite with polymeric shell contain dithizone was developed as a sensitive and selective sensor for adsorption and detection of mercury ions from aqueous solution at optimized condition. Living things such as animals, humans and plants required some basic needs such as air, food and water that are clean and adequate for continue survive. However, due to the growth of industrialization and urbanization, environmental sources, especially of water, have been polluted and this is predicted to become worse over time. This global issue is caused by agricultural and industrial waste products that are disposed into the oceans and rivers. Thus, the water is contaminated by organic and inorganic pollutants, toxic heavy metals, metalloids and synthetic organic chemicals. Heavy metal ions have become one of the major water pollutants, known as toxic and non-biodegradable substances that cause serious issues for the environment and human health. For instance, Cd2+, Hg2+ and Pb2+ are dangerous as they can exert impacts on the human body resulting in several fatal diseases such as kidney dysfunction, brain cancer and metabolic disorders. The contaminant levels of heavy metal ions in drinking water should follow the recommendations from environmental agencies such as the World Health Organization (WHO), the US Environmental Protection Agency (EPA) and the European Medical Agency (EMA). However, the concentrations of trace heavy metal ions have been exceeded and do not meet the allowed range. Therefore, the development of heavy metal ion sensors for the detection of pollution in water resources and the environment has been extensively developed by researchers worldwide.

To determine heavy metal ions in aqueous solutions effectively, various types of methods have emerged. The conventional analytic methods that are commonly used include atomic absorption spectroscopy (AAS), inductively coupled plasma–mass spectrometry (ICPMS), anodic stripping voltammeters (ASV) and X-ray fluorescence spectroscopy (XRF) these have successfully detected heavy metal ions in low concentrations and showed good selectivity to analytics. Unfortunately, their implementation is hampered by some limitations, such as the requirement of complex operation and the need for expensive instruments; these methods are also time-consuming processes. In light of these limitations, researchers have been attentive to optical methods for sensing a variety of heavy metal ions and other target materials, as electrochemical, electronic analyses and other modern methods do not offer the same features as optical sensors, which are facile, rapid, and cost-effective and have excellent sensitivity and selectivity towards analytics.

Thus, research focused on the technology of opti-

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cal sensors is promising in detecting heavy metal ions. Colorimetric, Electrochemiluminescence, fluorescence and surface Plasmon resonance are the list of optical sensors that have been developed to overcome the limitation of the before-mentioned sensors. A colorimetric sensor is an optical sensor involving changes of color of an indicator upon interaction with the analyses, which can be observed easily by naked eye or electronic devices. However, this technique has low sensitivity and low accuracy in producing a result. Next, fluorescence is the optical phenomenon of light emission of certain molecules after the absorption of photons. This technique has a limitation in that it has a long response time. Electrochemiluminescence involves the formation of electrochemically generated species that interact and undergo electron transfer reactions, which consequently emit light from excited states. This technique needs rather complicated operating processes. Surface Plasmon resonance is an optical process of the interaction between light and metal-dielectric materials. This optical method also has its own advantages and disadvantages and different sensing abilities in terms of selectivity and sensitivity.

Therefore, the effectiveness and efficiency of sensors should be improvised, and this has led to numerous works on the fabrication of sensing layers, which rely on different types of materials that have been used. Over the years, different materials such as graphene oxide polymers and quantum dots have been incorporated with optical sensors to enhance the sensitivity and selectivity. Novel and unique properties of materials are considered to determine suitable sensing materials. Because of interesting naturally-based characteristics, biopolymers including cellulose, nanocrystalline cellulose and chitosan have been actively investigated in the last decades. Intensive research works have been devoted to the preparation and characterization of biopolymer materials and applied as environmental sensors.

Cellulose is one of the most common polysaccharides and also an unlimited organic material in the Earth. This colorless and odorless polymer consists of several hundred to ten thousand linear chains of β-1, 4 linked to d-glucose units with the formula of ($C_6H_{10}O_5$) n. The non-toxic polymer also possesses many interesting and promising properties, including biocompatibility, high adsorption capacity, hydrophilicity, relative thermo stability and changeable appearance. Meanwhile, nanocrystalline cellulose is a cellulose nanocrystalline with nanoscale diameters of 1 to 5 nm and lengths in the range of 150 to 300 nm. By an acid hydrolysis process, this polymer can be synthesized, and the properties of the material can be enhanced for wide application. Next, chitosan is a linear amino polysaccharide of glucosamine and an N-acetyl glucosamine unit that can be obtained by alkaline deacetylation of chitin. This polymer can be easily synthesized by surrounding resources, abundantly available from the shells of crab, prawn, shrimps, fish scale and also from plant-based material. It is an excellent stabilizer of metal nanoparticles, has good biocompatibility and is a low cytotoxicity material.

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