A Novel, Fluorescent Nano-Based Sensor for Mercury in Seawater With High Sensitivity and Selectivity

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Salmon, tuna, shrimp, and almost all other seafood have been shown to contain variable amounts of mercury. The release of mercury into the environment has adverse effects on humans and aquatic species, even at very low concentrations. Pyrene and its derivatives have advantageous fluorescence properties which can be utilized for mercury (Hg2+) ion sensing. This project reports the highly selective pyrene-functionalized silica nanoparticles (Pyr-NH@SiO2 NPs) for chemo-sensing of mercury (Hg2+) ions in a real seawater sample. First, a modified Stöber method was adopted to generate amino-functionalized silica nanoparticles (NH2@SiO2 NPs). Second, 1-pyrenecarboxylic acid was coupled to NH2@SiO2 NPs using a peptide coupling reaction. As-synthesized NH2@SiO2 NPs and Pyr-NH@SiO2 NPs were investigated by 1H-NMR analysis. Third, the testing of Hg2+ ion sensing was performed in triplicate by using the developed Pyr-NH@SiO2 NPs in a broad concentration range, 0-50 ppm, via photoluminescence spectroscopy. The chemo-sensor was also tested in the presence of ubiquitous ions, such as Na+, K+, Ca2+, Mg2+, Ba2+, Ag+, and seawater samples. Consistently exhibiting a limit of detection of 10 ppb of Hg2+ and only showing drastic quenching (~60 %) of fluorescence intensity upon Hg2+ addition, the chemo-sensor demonstrated accuracy, sensitivity, and selectivity for mercury ion detection. The quenching of fluorescence properties with Hg2+ ions indicates that these NPs can be effectively utilized as a promising mercury chemo-sensor in fabricating portable sensing devices for mercury ion detection in seawater environments with high selectivity and sensitivity.

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