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CTAB Capped β-Naphthol Nanoparticles as Ratiometric Fluorescent Sensors for Cr (VI): Application to Environmental Sample

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The aqueous suspension of fluorescent β-naphthol organic nanoparticles using CTAB as capping agent (CTAB-BNNPs) was prepared by reprecipitation approach. The formation of CTAB-BNNPs confirmed by FESEM technique reveal nanoparticles with spherical morphology, and DLS-size analyzer supports a narrow particle size distribution with an average particle size of 89 nm. The absorption investigations of CTAB-BNNPs indicates blue shifted maximum at 275 nm as compared with monomer (λ_{ab} = 335 nm) whereas the fluorescence spectra of CTAB-BNNPs also supports to blue shifted emission maximum at 353 nm as compared with monomer BN (λ_{em} = 431 nm). This observation of blue shifted emission is due to the aggregation induced enhanced emission (AIEE). Furthermore, prepared nanoparticles show selective ratiometric sensing behavior toward $Cr_2O_7^{2-}$ ion only. This is because the electrostatic binding attraction between $Cr_2O_7^{2-}$ ions and oppositely charged nanochemosensor (CTAB-BNNPs) resulted in ground state complexation. The ratiometric fluorescence enhancement data was well-fitted into the calibration curve (R^2 = 0.99) and the estimated limit of detection (LOD) was found to be 0.2435 µg/mL, which is less than WHO acceptable limit for chromium in drinking water. This proposed analytical assay was successfully applied for the quantitative determination of $Cr_2O_7^{2-}$ ion in the river sample.

1. Introduction

In spite of great revolution across the world through chemical engineering and their research developments, human being is getting exposed to the environment of hazardous chemicals which includes heavy metal ions, carcinogenic materials, polluted water, etc. So, this has a noteworthy biological effect on the food chain and subsequently increases the illness to the human life by acquiring harmful diseases and disorders. Among the different metal ions, one of the harmful heavy metal components includes chromium, it ranks 21st in list of most abundant elements in earth crust, its trivalent (Cr (III)) and hexavalent (Cr (VI)) oxidation states are considered as crucial from environmental point of view. The Cr (VI) is considered as 100 times more toxic than Cr (III).[1] The WHO marked its hexavalent species as class I carcinogens.[2] In its hexavalent state, i.e., (Cr (VI)), which is commonly found in the form of chromates, dichromate and chromic acid.[3] The main sources of chromium contamination include industrial waste waters, activities in the production of metals, fumes and dust exerted from the industries, water contaminations, etc.[4–6] Though, Cr (III) is an essential trace element to the human body for maintaining protein and glucose metabolism, hexavalent chromium has significant adverse effect too.[1,7] According to World Health Organization (WHO), maximum acceptable limit for chromium in drinking water is 0.962 µM.[1] United state Environmental Protection Agency (USEPA) reported exposure of 1 mg/L of chromium for period of 10 days in drinking water does not shows any adverse effect in children, while FDA limits the concentration of chromium 1 mg/L in bottled drinking water.[8] The excessive intake of dichromate through any activities in the body can led to toxins effects such as respiratory problems including

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