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Dual sensing of copper ion and chromium (VI) oxyanions by benzotriazole functionalized UiO-66 metal-organic framework

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Metal–Organic, Frameworks (MOFs) with porous structure and high surface area has been extensively used for the capture and storage of carbon dioxide, hydrogen and methane. The finely tuned pores with functional sites have enabled us to use MOF in developing materials for separations of small and large molecules, sensing of different analytes, drug delivery, carbon dioxide conversion and heterogeneous catalysis. These pore environments can be engineered by using functionalized linkers for different potential applications. Low concentration of copper effects the enzyme activity owing to the redox-active nature while excessive accretion of copper cause damage to the liver and kidney, hepatolenticular degeneration (Wilson's disease), Alzheimer's diseases, Menkes syndrome, neutropenia and myelopathy. Moreover, chromate ion can cause allergic reaction in human and prolonged exposure results in chrome ulcer, contact dermatitis, and irritant dermatitis. In this work a new dual chemosensor UiO-66-NH-BT (BT=1-methylenebenzotriazole) based on the UiO-66 (University of Oslo) framework, containing benzotriazole functionalized dicarboxylate struts was synthesized and characterized. This isoreticular Metal-Organic Framework (MOF) was found to be a very selective and ultrasensitive for copper ion and chromium oxyanions in aqueous media. It showed a detection limit of 16.9 ppb (0.266 μM) for Cu2+ ion, 280 ppb (1.3 μM) for Cr2O72- and 47.7 ppb (0.411 μM) for CrO42- anions. The quenching constants (Ksv) for Cu2+, Cr2O72-, CrO42- was found to be 1.1x105, 3.9x103, and 6.7x103 respectively. The covalently bonded benzotriazole moiety with the UiO-66 framework not only produces an emission peak at 491 nm but also act as an intrinsic binding site for both cations and anions. The nature of the coordinative interaction between the analytes and the UiO-66-NH-BT has also been elaborated with the help of ICP and FTIR. This chemosensor also demonstrated a regenerative property without the loss in performance for five consecutive cycles.

Biography

Aasif Helal completed his PhD in 2010 in "Synthesis and Ion Sensing Properties of Thiazole based Receptors" from Kyungpook National University, South Korea in applied organic chemistry. The same year he was awarded "Best Researcher of the year 2009" by Kyungpook National University and joined as postdoctoral Fellow in the same university. In 2012 he joined Department of Material Science and Engineering at Seoul National University of Seoul, South Korea as a Post-Doctoral Fellow. He is currently working as a Research Scientist II in Center of Research Excellence in Nanotechnology, King Fahd University of Petroleum and Minerals, Saudi Arabia. His research interests include design and synthesis of novel organic molecular materials, and metal organic framework as sensors and catalysts for carbon dioxide conversion. He authored more than 43 publications in peer-reviewed international journals and holds 7 patents in addition to several conference proceedings/ presentations.