Uranium Extraction from Seawater around Sri Lanka using Amidoxime Modified Nano and Mesoporous Silica

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Amidoxime modified ordered nano & mesoporous silica (AO-OMS) materials were prepared for the first time by a two-step process involving: (1) synthesis of cyanopropyl-containing ordered mesoporous silica (CP-OMS) by cocondensation of (3-cyanopropyl) triethoxysilane (CPTS) and tetraethylorthosilicate (TEOS) in the presence of Pluronic P123 triblock copolymer under acidic conditions, and (2) conversion of cyanopropyl groups into amidoxime upon treatment with hydroxylamine hydrochloride under suitable conditions. The as-synthesized, extracted, and amidoximated mesoporous silica samples were characterized by variety of techniques such as thermogravimetry (TG), Fourier transform infrared spectroscopy (FTIR), nitrogen adsorption, small angle X ray diffraction (XRD), high resolution transmission electron microscopy (TEM), and CHNS analyzer. These characterizations permitted identifying internal-external surface properties and assuring functional groups formation inside the mesostructure. CP-OMS samples exhibit structurally ordered uniform mesoporous, high specific surface area, and narrow pore size distribution. The conversion of cyanopropyl incorporated OMS samples to amidoxime modified counterparts increased specific surface area, total pore volume, microporocity, and nitrogen content. The high affinity of amidoxime groups towards the uranyl ions makes the amidoxime-modified OMS materials as an attractive sorbents for uranium uptake. The presence of vast number of amidoxime binding groups further causes a momentous enhancement of the uranyl ions uptake (reaching 57 mg of U per grain of adsorbent). This proposed approach to obtain high uranium uptake is particularly important due to the low concentration (3 ppb) of uranium exists in the seawater around Sri Lanka. Simple and less time consuming co-condensation strategy assures high loading of cyanopropyl functionalities and full participation of all precursors in the structure formation as compared with the typical post-grafting technique where radiation induced graft polymerization or suspension polymerization is used. The resulting amidoxime- modified OMS materials, because of their remarkable uranium recovery, are of great interest for alternative resource to generate nuclear power in the near future in Sri Lanka.

keywords: Uranium extraction, Sea water, Nuclear power, Amidoxime, Silica