Phosphonic Acid Functionalized Electrospun Nanofibers for Uranium (VI) Uptake

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Abstract

In the Four Corners region of the United States, Native American communities are threatened with exposure to high concentrations of uranium in the drinking water due to leakage from local abandoned uranium mines. Increased levels of uranium exposure pose health concerns as uranium is considered a nephrotoxin, which has many harmful consequences including the potential increased risk for cancer. The most prevalent form of uranium in aqueous solution is U(VI) in the form of the uranyl cation. The goal of this project is detection of U(VI) in groundwater and eventually extraction, which we target through the coupling of engineering concepts with chemical techniques to develop new material and understand binding preferences of U. Initial efforts use polyacrylonitrile (PAN) electrospun nanofibers, which are combined with various phosphonic acid surfactants for selective uptake of U. Changing the surfactants chemistry via adjustment of the carbon chain (resulting in increased hydrophobic nature of the tail), total uptake of uranium is observed with the longer chains, confirmed by both LSC and ICP-MS results. In addition, stability of the surfactants were assessed and washing experiments indicated variable incorporation of the phosphonate groups that are dependent on chain length.

Objective

Previous research determined that hexadecyl phosphonic acid (HDPA) is useful for uranium detection because of its high uranium sorption concentration. Elongating the chain on the phosphonic acids changes the hydrophobicity of the mat, which in turn affects uranium uptake.

Instrumentation

A rotator (A) is used so the nanofiber mats are mixed with uranium solution. Uranium uptake on nanofiber mats were calculated by using LSC as shown above (B) which detects the counts of beta radiation emission. The remaining solution is acidified in HNO\textsubscript{3} and analyzed on ICP-MS (C) which detects the concentration of uranium.

Future Studies and Conclusion

Future work will involve synthesizing nanofiber mats with PAN and various functionalized acids for testing for uranium uptake. The nanofiber mats uranium uptake will be analyzed and compared to the corresponding hydrophobicities.

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