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**RECOVERY AND DETECTION OF URANIUM (VI) FROM BUILDING MATERIALS**

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**ABSTRACT**

As a legacy of the United States' 50-year-old nuclear weapons program, the Department of Energy is responsible for cleaning up and decommissioning contaminated sites that were used for nuclear weapons' production. Although a significant amount of effort has gone into the detection of metal ions in ground waters, detecting toxic metals, such as uranium, in building materials has proven to be difficult<sup>1,2</sup>.

Previously, concrete samples have been tested for uranium exposure using anion exchange followed by inductively coupled plasma-mass spectroscopy (ICP-MS)<sup>3</sup>. Although successful in detecting uranium in concrete, this method required core drilling, concrete dissolution and uranium concentration prior to ICP-MS analysis. Another method reported for the detection of uranium in building materials required the use of a shielded high purity germanium detector for measuring the amount of uranium in cement, sand and aggregate<sup>4</sup>. The method was capable of detecting uranium at the parts-per-million level (ppm), but the instrumentation used in this method required cryogenic cooling, lacked portability and was prohibitively expensive.

There is a need for a portable sensor that is capable of rapidly detecting trace metal cations in building materials. In this project, the solid surface extraction and quantitation

of uranium (VI) from concrete was examined. Specifically, uranium (VI) is removed from concrete surfaces using a low pH buffer rinse that dissolves the carbonate surface layer and any bound contaminants. The amount of uranium in the wash solution can be quite low, even with extraction efficiencies exceeding 50 percent. The uranium is subsequently complexed using an organic chelating agent (arsenazo III) and concentrated using C<sub>18</sub> solid phase extraction. Because the absorbance maximum of arsenazo III shifts upon binding to uranium, the concentrated complex can be detected using ultraviolet-visible spectroscopy. Low part-per-billion (ppb) levels of uranium (VI) in cement have been detected using this method.

Some concerns with interferences and portability were also addressed in this study. One known interferent in concrete analysis with arsenazo III is calcium, a major component of concrete<sup>5</sup>, which binds tightly with arsenazo III. To avoid interference from calcium ion, the absorbance spectra of arsenazo III-calcium and arsenazo III-uranium complexes were studied over a pH range of 2.0 to 5.5. It was determined that the optimal pH for detection uranium (VI) in the presence of calcium ion is between a pH of 2 and 2.5. Under these conditions, arsenazo III complexes uranium (VI) strongly while calcium ion largely remains uncomplexed. EDTA, a masking agent, was added to further minimize the interference from the high concentration of calcium ion present in the concrete samples. At this pH, other metal ions such as cerium (III), iron (II), iron (III), magnesium, aluminum and thorium (IV) did not interfere.

The design, performance and portability of the uranium detection method will be described. Future goals, such as integration with microfluidic devices, will also be discussed.

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