Development of a Rapid, High-Throughput Method for Quantifying Residual Caesium in Building Materials as Part of a Decontamination Evaluation Procedure

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An attack on infrastructure mediated via a radiological dispersion device (RDD) remains a credible threat, with radioactive caesium (^{137}Cs) being of particular concern. Therefore, it is imperative to identify and assess available equipment and develop appropriate strategies to safely remove radiological contamination. Laboratory-based evaluation of building decontamination procedures can be assessed using stable Cs to avoid environmental, cost and safety constraints associated with the radioactive isotope. A commonly used analytical technique for Cs is inductively coupled plasma mass spectrometry (ICP-MS), which is highly sensitive but involves a time consuming, labour intensive, expensive and potentially hazardous sample preparation that can slow efforts the evaluation of decontamination products and methods.

The aim of this initial study was to assess ion-exchange liquid chromatography mass spectrometry (IE-LC-MS) as a potential high throughput replacement for ICP-MS. Concrete was chosen as a test substrate, given its prevalence as a building material. The experiment involved exposing concrete bricks to a 20 µL droplet of aqueous CsCl (11 mg mL^{-1}). After a delay of 0 – 20 days, the bricks were decontaminated (by one of three methods) or remained untreated (control). The exposed surfaces of the bricks were then drilled to a depth of 10 mm to generate powder samples which were subject to a standard ICP acid digestion protocol [1]. The resulting acid solutions were filtered and analysed by ICP-MS or IE-LC-MS.

There was a good correlation ($p<0.0001$ to $p=0.0298$) between Cs quantified by ICP-MS and IE-LC-MS. The limit of detection for the IE-LC-MS method was 20 ppb which contrasted poorly with ICP-MS (LoD = 0.1 ppb). However, the lower sensitivity of the IE-LC-MS method would be sufficient for the initial screening of decontamination products.

The next stage of the project will determine if cement powder samples can be extracted using just water prior to quantification by IE-LC-MS, to avoid the acid digestion process and thus significantly reduce the time, cost and hazard of Cs sample analysis.

[1] U.S. EPA. 2007. Method 3051A (SW-846). Revision 1. Washington, DC.