

IMPROVEMENTS TO THE ANALYSIS OF LANTHANIDES IN NUCLEAR FORENSICS SAMPLES

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Lanthanides are important fingerprint elements for nuclear forensics. Lanthanides are classed in the side group 3 of the periodic table and are conventionally known as rare earth elements (REE). The lanthanides typically appear in oxidation state +III and are typically present in aqueous solution as Ln^{3+} ions, except for cerium, which has the potential to be oxidized to +IV. Yttrium is also +III in solution and behaves as the lanthanides, it is therefore purified as a pseudo member of the lanthanides.

The intra-group separation of lanthanides is very difficult because the lanthanides behave chemically similar. Common methods for group separation rely on the small differences in the interaction with organic extractants resulting from small changes in ionic radii across the lanthanide group. The smaller the difference in ionic radius results in a more difficult separation. Samarium and europium often co-elute from extraction resins as do europium and terbium; elution of yttrium is dependent on the extractant used and has the potential to co-elute with several lanthanides.

A new method using Eichrom LN resin has been developed in order to improve the intra-group lanthanide separation. LN resin uses the extractant di(2-ethylhexyl)orthophosphoric acid (HDEHP) coated onto a solid resin support. The lanthanides and yttrium are eluted using an acid gradient where the acid concentration is changed over the course of the separation such that elements of interest are separated in a reasonable amount of time. A series of method validation and optimisation experiments have been carried out using various resin size, column size, sample mass and matrix. Samarium, europium, terbium, and yttrium have been successfully separated in the presence of all the lanthanide elements. The separation takes 7 to 12 hours depending on the experimental setup. The optimized method has been used in recent nuclear forensics exercises. Results will be presented in this talk and compared with those obtained by the conventional method.