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The isolation of terbium isotopes from matrix and isobaric impurities using extraction chromatography techniques

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Four terbium isotopes (149Tb, 152Tb, 155Tb, and 161Tb) have been shown to possess physical and chemical properties suitable for all therapeutic and diagnostic applications in nuclear medicine[1]. If a diagnostic (e.g. 155Tb) and therapeutic (e.g. 161Tb) terbium isotope can be combined, then it would give theranostic pair with identical chemical properties. This is a particularly promising characteristic because it will facilitate the development of personalised medicine.

Currently, 149Tb, 152Tb, and 155Tb can only be produced in sufficient quantities for (pre)-clinical studies by the proton-induced spallation reaction on a tantalum target and subsequent mass separation, as is the case at CERN-MEDICIS. Alternative cyclotron-based production has been investigated; primarily, the proton irradiation of enriched gadolinium targets[2,3]. Terbium-161 can be produced by neutron irradiation of an enriched 160Gd target (i.e. 160Gd(n,γ)161Gd -> 161Tb + β-)[4]. The presence of isobaric (e.g. 152Dy in a 152Tb source) and pseudo-isobaric (e.g. 139Ce16O in a 155Tb source) impurities after the mass separation of 149Tb, 152Tb and 155Tb sources necessitates effective radiochemical separation procedures to achieve a high purity and specific activity prior to subsequent (pre)-clinical studies. The isolation of 161Tb from the target material, 160Gd, is also required to achieve the same.

The isolation of terbium from neighbouring lanthanide elements has been studied from nitric acid solutions on LN resin (Triskem International), an extraction chromatography resin based on the liquid extractant, HDEHP. Stable element standards were used for method development and measured by inductively coupled plasma mass spectrometry (ICP-MS) to quantify the quality of the separation. Both batch and column studies were conducted to identify the optimal separation conditions.

References

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Primary authors: Mr WEBSTER, Ben (The National Physical Laboratory, University of Surrey); IVANOV, Peter (National Physical Laboratory); Dr RUSSELL, Ben (The National Physical Laboratory); READ, David (University of Surrey)

Presenter: Mr WEBSTER, Ben (The National Physical Laboratory, University of Surrey)

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