Development and Assessment of New Chelator Resins for Ti and Sc Isotope Separation

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1 - Introduction

- The $^{4+}$Ti$^{4+}$Sc generator has potential for clinical use for production of $^{48}$Sc ($t_{1/2}=3.97$ h, $\beta^+=94.27\%$, $E_{\beta^+}=652.0$ keV, $E_{\beta^+}\text{max}=1474$ keV)
- Use is hampered by poor separation of $^{48}$Sc from the long-lived mother isotope $^{44}$Ti ($t_{1/2}=60$ y), and common elution methods requiring toxic oxalic acid
- The isotope $^{44}$Ti ($t_{1/2}=3.08$ h, $\beta^+=85\%$, $E_{\beta^+}\text{avg}=0.439$ MeV, $E_{\beta^+}\text{max}=1.04$ MeV) is an ideal candidate for PET imaging, produced by proton bombardment of naturally monoisotopic Sc foil via the $^{48}$Sc(p,$n$)$^{44}$Ti reaction between 7-13.5 MeV. The $^{44}$Ti is typically eluted in 0.1-1.0 M citric or oxalic acid
- A lack of efficient separation methods due to the complex speciation and chelation behavior of Ti(IV) has prevented use of $^{44}$Ti in nuclear medicine to date.

2 - Chelator-Based Resins for Separation of Ti$^{4+}$ and Sc$^{3+}$

- The highly basic deferiprone (def) and catechol (cat) chelators have been previously shown by our group to effectively stabilize titanium in aqueous solution
- Can def and cat chelators be immobilized on solid phase and effectively separate Ti$^{4+}$ and Sc$^{3+}$ under mild acidic conditions?

3 - CA-Def/Sc Separation Analysis

- Can the CA-Def resin separate trace Ti$^{4+}$ from bulk Sc$^{3+}$?
- Can additional impurities such as Fe$^{3+}$ be removed in the loading step, or with additional washing steps?

4 - $^{4+}$Ti$^{4+}$Sc Separation Analysis

- Can chelator-based resins separate bulk Ti$^{4+}$ from trace Sc$^{3+}$ under mild conditions?
- Is breakthrough of $^{44}$Ti reduced?
- Do the separation properties of immobilized chelators closely resemble that of the solution speciation?

Retention of Ti

Retention of Sc

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References: