LANTHANIDE TARGET FOILS FOR THE EXPLORATION OF TARGETED ALPHA THERAPY PRODUCTION MECHANISMS

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MOTIVATION

■ Targeted alpha therapy (TAT) is rapidly coming to the frontiers of radiotherapeutic cancer research due to its high cell mortality rate when localized to the cancer site via a targeting agent. While radium-223, actinium-225, and astatine-211 are at the forefront of this research, all of these isotopes require separate isotopes for imaging (theragnostic pairs), since their alpha decays cannot be imaged outside of the body. A lesser known prospect for TAT is terbium-149, which decays via both positron and alpha emission, allowing it to be its own theragnostic pair, and eliminating the need for an imaging analog. However, it does not yet have a well-established production pathway via direct reaction. In order to probe potential reaction mechanisms for its production, a series of experiments will be executed which require the production of isotopically enriched samarium and gadolinium targets.

REACTION MECHANISMS

- 147Sm(6Li,4n)149Tb−45 MeV
- 148Sm(6Li,5n)149Tb−55 MeV
- ¹⁴⁹Sm(⁶Li,6n)¹⁴⁹Tb— 65 MeV
- ¹⁵²Gd(p,4n)¹⁴⁹Tb– 40 MeV

¹⁴⁹ Tm _{900 ms}	¹⁵⁰ Tm	¹⁵¹ Tm _{4.17 s}	¹⁵² Tm	¹⁵³ Tm _{1.48 s}	¹⁵⁴ Tm _{8.1 s}	¹⁵⁵ Tm _{21.6 s}	¹⁵⁶ Tm 83.8 s	¹⁵⁷ Tm _{217.8 s}	¹⁵⁸ Tm _{238.8 s}	¹⁵⁹ Tm _{9.13 m}
¹⁴⁸ Er _{4.6 s}	¹⁴⁹ Er	¹⁵⁰ Er	¹⁵¹ Er _{23.5 s}	¹⁵² Er 10.3 s	¹⁵³ Er 37.1 s	¹⁵⁴ Er 223.8 s	¹⁵⁵ Er 5.3 m	¹⁵⁶ Er	¹⁵⁷ Er _{18.65 m}	¹⁵⁸ Er _{137.4 m}
¹⁴⁷ Ho _{5.8 s}	¹⁴⁸ Ho	¹⁴⁹ Ho _{21.1 s}	¹⁵⁰ Ho _{76.8 s}	¹⁵¹ Ho _{35.2 s}	¹⁵² Ho _{161.8 s}	¹⁵³ Ho _{120.6 s}	¹⁵⁴ Ho _{11.76 m}	¹⁵⁵ Ho	¹⁵⁶ Ho _{56 m}	¹⁵⁷ Ho _{12.6 m}
¹⁴⁶ Dy _{33.2 s}	¹⁴⁷ Dy	¹⁴⁸ Dy	¹⁴⁹ Dy _{4.2 m}	¹⁵⁰ Dy _{7.17 m}	151 Dy 17.9 m	¹⁵² Dy _{142.8 m}	¹⁵³ Dy _{6.4 h}	¹⁵⁴ Dy ^{3 My}	¹⁵⁵ Dy _{9.9 h}	¹⁵⁶ Dy
¹⁴⁵ Tb _{30.9 s}	¹⁴⁶ Tb	¹⁴⁷ Tb _{98.4 m}	¹⁴⁸ Tb	¹⁴⁹ Tb _{4.118 h}	¹⁵⁰ Tb _{208.8 m}	¹⁵¹ Tb _{17.609 h}	¹⁵² Tb _{17.5 h}	¹⁵³ Tb _{56.16 h}	¹⁵⁴ Tb _{9.994 h}	¹⁵⁵ Tb _{5.32 d}
¹⁴⁴ Gd _{4.47 m}	¹⁴⁵ Gd	¹⁴⁶ Gd _{48.27} d	¹⁴⁷ Gd _{38.06 h}	¹⁴⁸ Gd _{71.3 y}	¹⁴⁹ Gd _{9.28 d}	¹⁵⁰ Gd _{1.79 My}	¹⁵¹ Gd _{123.9} d	¹⁵² Gd 108 Ty	¹⁵³ Gd _{240.6} d	¹⁵⁴ Gd
¹⁴³ Eu _{155.4 s}	¹⁴⁴ Eu _{10.2 s}	¹⁴⁵ Eu _{5.93 d}	¹⁴⁶ Eu _{4.61 d}	¹⁴⁷ Eu _{24.1 d}	¹⁴⁸ Eu _{54.5 d}	¹⁴⁹ Eu _{93.1 d}	¹⁵⁰ Eu ^{36.9 y}	¹⁵¹ Eu _{4.6 Ey}	¹⁵² Eu _{13.517 y}	¹⁵³ Eu
¹⁴² Sm _{72.49 m}	¹⁴³ Sm _{8.75 m}	¹⁴⁴ Sm	¹⁴⁵ Sm ^{340 d}	¹⁴⁶ Sm _{68 My}	¹⁴⁷ Sm _{106.6 Gy}	¹⁴⁸ Sm _{6.3 Py}	¹⁴⁹ Sm	¹⁵⁰ Sm	¹⁵¹ Sm _{94.6 y}	¹⁵² Sm
¹⁴¹ Pm	¹⁴² Pm _{40.5 s}	¹⁴³ Pm	¹⁴⁴ Pm	¹⁴⁵ Pm	¹⁴⁶ Pm _{5.53 y}	¹⁴⁷ Pm _{2.6234 y}	¹⁴⁸ Pm _{5.368 d}	¹⁴⁹ Pm _{53.08 h}	¹⁵⁰ Pm _{161.88 m}	¹⁵¹ Pm _{28.4 h}

___Target Nucleus

Compound

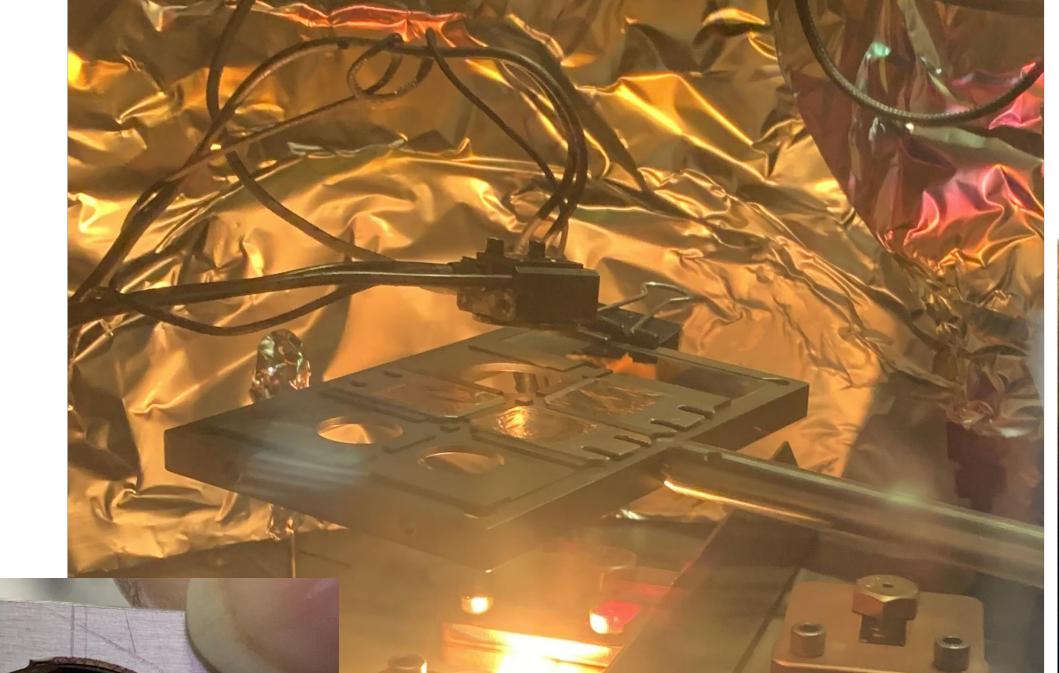
Product Nucleus

SAMARIUM TARGETS

- Sm₂O₃ powder
- Low melting point lanthanide
- Vapor deposition
- 1 mg/cm²
- Ta pinhole boat
- $3Zr + 2Sm_2O_3 \rightarrow 3ZrO_2 + 4Sm$
- Monitor heat of frame– < 60°C: metallic
 - -> 60°C: oxidized

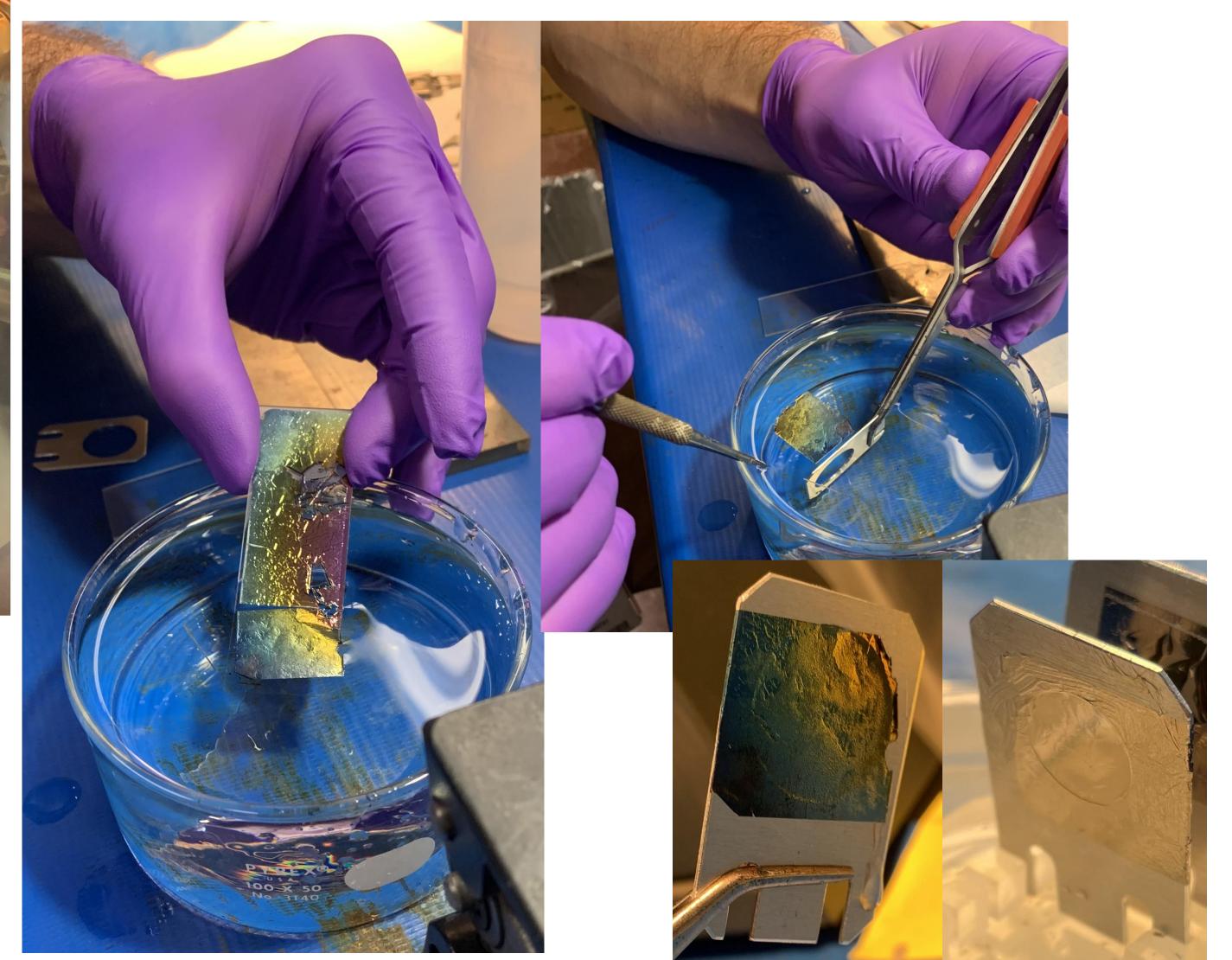
Aluminum Backed







- NaCl coated microscope slides, via vapor deposition
- Vapor deposition of Sm
- Floated Sm off of slide in H₂O



GADOLINIUM TARGETS

High melting point lanthanide

Electroplating

■ Convert Gd₂O₃ powder to GdCl₃ with 0.2 M HCl

Evaporated to dryness

Dissolved in 0.01 M HCI

■ Diluted to 20 mL in EtOH

■ Voltage: 10, 60, & 200 V

Current: 2 mATime: 1 hr

Salt targets produced

Pt Anode

Pt Anode

Al Target
Backing

Cell (HCl,
EtOH, GdCl₃)

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