Development of cyclotron targets for ^{52}Mn, ^{67}Cu, ^{103}Pd, ^{135}La, and ^{165}Er production

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AIM

At the Hevesy laboratory, we aim to develop reliable and efficient cyclotron targets to produce novel radionuclides. The target materials need to be of high purity, be able to tolerate the beam, form a homogenous layer and adhere efficiently to the target backing. We used electroplated targets for manganese-52 (^{52}Mn), copper-67 (^{67}Cu), and palladium-103 (^{103}Pd) production, while pressed targets were developed for lanthanum-135 (^{135}La) and erbium-165 (^{165}Er) production containing fine aluminum powder as a thermal filler.

Electroplating process

Hydraulic press with stainless steel piston and anvil

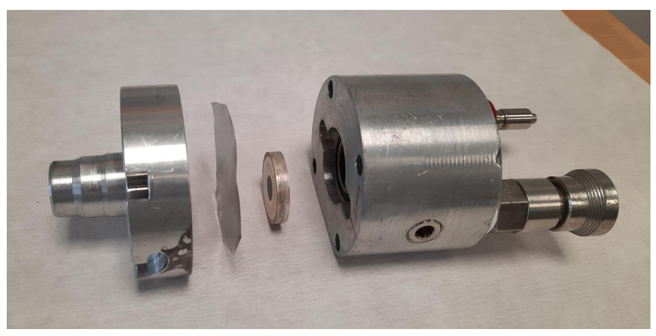
MATERIALS AND METHODS

Target preparation

Electroplated targets were prepared by using a silver backing for ^{52}Mn and ^{67}Cu production [1] and a graphite backing for ^{103}Pd production placed in an Al holder as cathode and a Pt wire as anode. Electrodeposition of lanthanides can be challenging, and Ba oxidizes easily, so pressed targets for ^{135}La and ^{165}Er production were made from mixtures of fine Al powder and enriched [^{135}Ba]$BaCO_3$ and Ho_2O_3, respectively, and pressed (0.5-1 t) into a Ø 9 x 3 mm deep recesses in the silver backing. [2] All of our backings are 29 mm outer diameter and 5 mm thick, with water cooling on the back.

Target irradiation

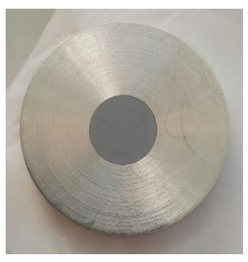
The targets were irradiated on a 16.5 MeV GE PETtrace cyclotron using a target holder with water cooling on the back of the target backing.



Target body showing degrader foil and target on backing

RESULTS

^{52}Mn production



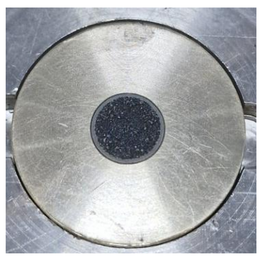
Electroplated ^{nat}Cr target
50-58 mg

No foil
6 h at 60 µA

Target after irradiation
^{52}Mn yield 2.3 ± 0.2 MBq/µAh

- ✓ Tolerate high current
- ▪ Not tested with enriched material

^{67}Cu production



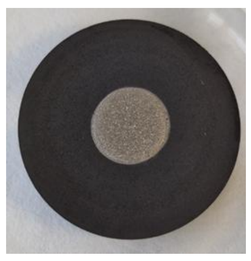
Electroplated ^{70}Zn target
98-120 mg

No foil
9 h at 60 µA

Target after irradiation
^{67}Cu yield 0.7 ± 0.1 MBq/µAh

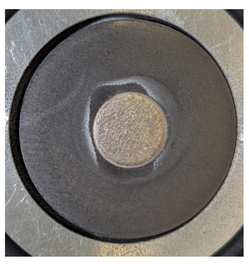
- ▪ High beam tolerance, but some material dispersion
- ✓ Possible to recycle ^{70}Zn[Zn]

^{103}Pd production



Electroplated ^{nat}Rh target
23-47 mg

0.8 mm Al foil
10 h at 20 µA



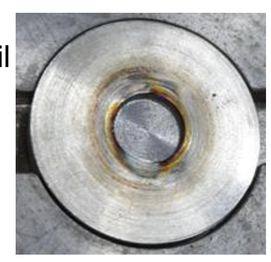
Target after irradiation
^{103}Pd yield 2.0 ± 0.6 MBq/µAh

- ▪ Limited to 20 µA
- ▪ Porous graphite backing is a challenge
- ✓ Possible to recycle Rh

^{135}La production

Pressed [^{135}Ba]$BaCO_3$/Al target (1/2, w/w) 200 mg

0.05 mm Nb foil
5 h at 20 µA



Target after irradiation
^{135}La yield 20.3 ± 2.3 MBq/µAh

- ▪ Limited to 20 µA
- ✓ Possible to recycle [^{135}Ba]$BaCO_3$

^{165}Er production

Pressed $^{nat}Ho_2O_3$/Al target (1/1, w/w) 180 mg

0.1 mm Nb foil
15 min at 35 µA

Target after irradiation
^{165}Er yield 12.5 ± 1.6 MBq/µAh

- ✓ Acceptable beam tolerance
- ✓ Inexpensive target material

CONCLUSION

- Targets for ^{52}Mn, ^{67}Cu, and ^{103}Pd production were made by electrodeposition.
- Pressed targets were used for ^{135}La and ^{165}Er production. Al powder as thermal filler improved the target robustness.
- All five radionuclides are available in an amount and purity suitable for preclinical studies.

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[1] U. Søndergaard, et al., *Applied Radiation and Isotopes*, 2025, 215, 1115511. [2] K. S. Pedersen, et al., *Applied Radiation and Isotopes*, 2023, 192, 110612.