Brazed Molybdenum Targets for Cyclotron Production of Technetium-99m‡

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Introduction

Technetium-99m, supplied in the form of ^{99}Mo/^{99m}Tc generators, is the most widely used radioisotope for nuclear medical imaging. The ^{99}Mo parent is currently produced in nuclear reactors. Recent disruptions in the ^{99}Mo supply chain [1] prompted the development of methods for the direct accelerator-based production of ^{99m}Tc.

Our approach involves the ^{100}Mo(p,2n)^{99m}Tc reaction on isotopically enriched molybdenum using small medical cyclotrons (E_p ≤20 MeV), which is a viable method for the direct production of clinically useful quantities of ^{99m}Tc [2].

Multi-Curie production of ^{99m}Tc requires a ^{100}Mo target capable of dissipating high beam intensities [3]. We have reported the fabrication of ^{100}Mo targets by electrophoretic deposition and sintering [4]. As part of our efforts to further enhance the performance at high beam intensities, we have developed an improved target system (initially designed for the GE PETtrace cyclotron) based on a pressed and sintered ^{100}Mo plate brazed onto a dispersion-strengthened copper backing.

Materials and Methods

In the first step, a molybdenum plate is produced similarly to the method described in [5] by compacting approximately 1.5 g of ^{100}Mo powder using a cylindrical tool of 20 mm diameter. A pressure between 25 kN/cm^2 and 250 kN/cm^2 is applied by means of a hydraulic press.

The pressed molybdenum plate is then sintered in a reducing atmosphere (Ar/2% H_2) at 1,700 °C for several hours. The resulting ^{100}Mo plates have about 90-95% of the bulk density of molybdenum.

The ^{100}Mo plate is furnace brazed at ~750 °C onto a backing manufactured from a dispersion strengthened copper composite (e.g. Glidcop AL-15) using a high temperature silver-copper brazing filler.

This process yields a unique, mechanically and thermally robust target system for high beam power irradiation.

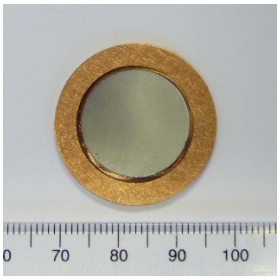

Figure 1. Brazed Mo-Cu Target Disc for GE PETtrace Cyclotron

Production tests were performed on the GE PETtrace cyclotrons at LHRI and CPDC with 16.5 MeV protons and beam currents ≥100 µA. Targets were visually inspected after a 6 hour, 130 µA bombardment (2.73 kW/cm^2, average) and were found fully intact. Up to 4.7 Ci of ^{99m}Tc have been produced to date. The saturated production yield remained constant between 2 hour and 6 hour irradiations.

Results and Conclusion

These results demonstrate that our brazed target assembly can withstand high beam intensities for long irradiations without deterioration. Efforts are currently underway to determine maximum performance parameters.

References

1. T. J. Ruth: *Nature* **457**, 536-537 (2009)
2. S.M. Qaim, S. Súdar, B. Scholten, A.J. Koning, H.H. Coenen: *Appl. Radiat. Isot.* **85**, 101-113 (2014)
3. F. Bénard, K. R. Buckley, T. J. Ruth, S.K. Zeisler, J. Klug et al.: *J. Nucl. Med.* **55**, 1-6 (2014)
4. V. Hanemaayer, F. Bénard, K.R. Buckley, J. Klug, M. Kovacs et al.: *J. Radioanalyt. Nucl. Chem.* **299**, 1007-1011 (2014)
5. K. Gagnon: *Cyclotron Production of Technetium-99m.* PhD Thesis, University of Alberta (2012)

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