Cyclotron Production and Cyclometallation Chemistry of ^{192}Ir

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Introduction

To explore new questions and techniques in nuclear medicine, new isotopes with novel chemical and nuclear properties must be developed. We are interested in the small cyclotron production of new radiometals for the development of new radiopharmaceuticals (RX). In an example of RX multifunctionality, Luminescence Cell Imaging (LCI) has been combined with radioisotopes to allow compounds that can be imaged with both optical microscopy and nuclear techniques [1]. Within this field, iridium cyclometalates have good potential with excellent photophysical properties [2]. As well, low specific activity iridium-192 has found use in brachytherapy as a high-intensity beta emitter [3]. Despite this, iridium radioisotopes have yet to be applied to cyclometalation chemistry, or a radiochemical isolation method developed for carrier free production on a medical cyclotron. Our goal is to demonstrate the feasibility of the production and isolation of radio-iridium, and its application to cyclometalate chemistry as a potentially interesting tool for nuclear medicine research.

Materials and Methods

Following literature precedent [4], natural osmium was electroplated onto a silver disc from basic media containing osmium tetroxide and sulphamic acid. The thin deposits obtained (15–20 mg cm^{-2}) were weighed and characterized with scanning electron microscopy.

Targets were irradiated using the TRIUMF TR13 cyclotron, delivering 12.5 MeV protons to the target disc. Initial bombardments were performed at 5 µA; gamma spectra of the targets were collected 24 hours after end of bombardment.

The irradiated material was oxidized, dissolved from the target backing, and separated via anion exchange.

In parallel to the isotope production work, non-radioactive iridium was used to define a chemical procedure suitable for the synthesis of model iridium cyclometalate compounds given low concentrations of radioiridium. These experiments will be performed with radioactive iridium in the next step of the research project.

Results and Conclusion

Proton bombardment of natural osmium yielded a range of iridium isotopes, with characteristic spectral lines corresponding to $^{186\text{-}190}$Ir, and ^{192}Ir; no other characteristic radiation was observed. The EOB activity of each isotope was then used in thin target calculations to approximate their (p,n) cross section. Preliminary cross section measurements of the ^{192}Os(p,n)^{192}Ir reaction (53 ± 13 mb @ 12.5 MeV) confirm published data (52.3 ± 5.7 mb @ 12.2 MeV) [6], and provide as-yet unpublished data on the lower mass number isotopes.

The progress of radioactive iridium through the radiochemical separation was tracked with a dose calibrator; the osmium complex formed was brightly coloured and could be seen retained on the column. The overall efficiency of the process is estimated at 80 %. Radioactive cyclometallation chemistry is currently underway.

The production and isolation of a range of iridium isotopes in a chemically useful form was demonstrated, and is ready to be applied to a cyclometalate model compound. Future work will investigate the production of ^{192}Ir from enriched ^{192}Os.

References

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