# Measurement of activation cross sections of alpha particle induced reactions on iridium up to an energy of 50 MeV†

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$^{195m}$Pt has proper decay characteristics for internal therapy investigations ($T_{1/2} = 4.03$ d, IT = 100%, $E_\gamma = 98.9$ keV, and $I_\gamma = 11.4\%$). This isomeric state transfers its energy by internal transition and emits low energy gamma photons, conversion electrons, and Auger electrons with high intensity. Owing to the low energy of the emitted conversion and Auger electrons, their energy is deposited in a very short range and then, most parts of the deposited energy get concentrated in a small volume, preferably in a single targeted cell. In addition, its low energy gamma photons can be used for imaging. $^{195m}$Pt can be attached to platinum complexes, which are used for chemotherapy, and thus, it can be applied as an effective anti-tumor agent in radiotherapy.

The $^{195m}$Pt for medical applications is produced in reactors in the $^{194}$Pt(n, $\gamma$)$^{195m}$Pt reaction with a moderate yield and low specific activity. Charged particle induced reactions may provide high specific activity isotopes. Several production routes to produce $^{195m}$Pt were investigated previously but the $^{nat}$Ir($\alpha$, x)$^{195m}$Pt reaction was not studied. The high spin isomeric state ($13/2^+$) of $^{195}$Pt can be formed in a reaction with particles capable to transfer high angular momentum. Thus alpha particle bombardment is one of the best ways to produce this radionuclide.

We measured the cross sections of alpha particle induced nuclear reactions on natural iridium using a 51.2-MeV alpha particle beam. The standard stacked-foil target technique and activation method were applied. The activity of the reaction products was assessed without chemical separation using high resolution gamma spectrometry based on a HPGe detector (ORTEC GEM-25185-P).

Two stacks containing Ir target and Ti monitor foils were irradiated at the AVF cyclotron in the RIKEN RI Beam Factory, Wako, Japan, in a Faraday-cup-like vacuum chamber equipped with a long collimator, assuring a small solid angle for the escaping secondary electrons. The initial beam energy was confirmed by the measurement of time of flight before and after the irradiation.[1)] The beam current was kept constant during the irradiation. The beam parameters were also monitored by the $^{nat}$Ti($\alpha$, x)$^{51}$Cr monitor reaction.

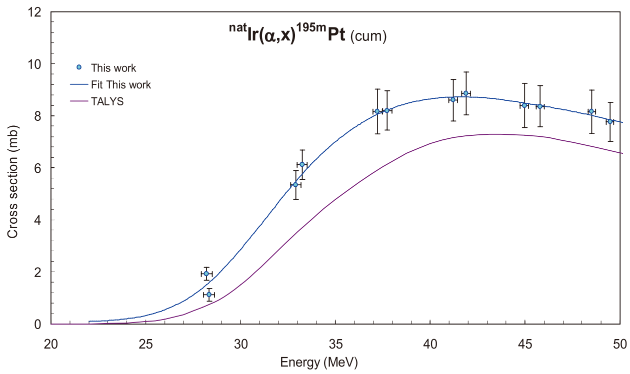


Fig. 1. Cross sections of $^{nat}$Ir($\alpha$, x)$^{195m}$Pt reaction in comparison with the predicted data calculated by the TALYS nuclear model code system.[2)]

Excitation functions for the production of $^{196m2}$Au, $^{196m,g}$Au, $^{195m,g}$Au, $^{194}$Au, $^{193m,g}$Au, $^{192}$Au, $^{191m,g}$Au, $^{191}$Pt, $^{195m}$Pt, $^{194g}$Ir, $^{194m}$Ir, $^{192g}$Ir, $^{190g}$Ir, and $^{189}$Ir isotopes were determined up to 50 MeV alpha particle energy on natural iridium target. The measured data were compared to the available experimental data and results of theoretical calculations.[2)] Figure 1 shows the excitation function for the $^{nat}$Ir($\alpha$, x)$^{195m}$Pt reaction.

The $^{nat}$Ir($\alpha$, x)$^{195m}$Pt production route utilizes the natural iridium target and provides high specific activity of $^{195m}$Pt. The radio-purity of $^{195m}$Pt produced by cyclotrons on iridium targets is somewhat lower than the reactor produced $^{195m}$Pt due to the unavoidable co-produced $^{193}$Pt and $^{191}$Pt radionuclides but the amount of these two isotopes can be reduced by using the enriched $^{193}$Ir target material, and at the same time, the amount of $^{195m}$Pt can be increased. Irradiating an $^{193}$Ir target enriched to 95% with alpha particles of an energy of 50 MeV and beam intensity of 200 $\mu$A for 24 h, activity of about 1 GBq of $^{195m}$Pt can be achieved at the end of the bombardment.

Besides the excitation function of the $^{nat}$Ir($\alpha$, x)$^{195m}$Pt reaction, we measured the cross-section data for the production of $^{196m2}$Au, $^{196m,g}$Au, $^{191}$Pt, $^{194g}$Ir, $^{194m}$Ir, $^{190g}$Ir, and $^{189}$Ir isotopes for the first time. The measured cross sections may also contribute to the improvement of theoretical model codes.

References

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† Condensed from the article in Appl. Radiat. Isot. **136**, 133 (2018)

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