# Fabrication of Calcium-Gold and Calcium-Lead Targets for Ion Beam Experiments at TRIUMF ISAC-II

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## Introduction

Multi-layer thin targets play an important role in low-energy nuclear physics experiments with accelerated beams. For example, targets with an evaporated thin reaction layer on a heavy stopper backing material are used in excited-state nuclear lifetime measurements. The typical challenges in fabricating such targets are providing a uniform deposition of the reaction layer with good adhesion to the backing and with minimal mixing of layers. Additional challenges arise when chemically reactive elements must be employed.

In a recent measurement at TRIUMF's ISAC-II facility, experimenters required a calcium reaction target evaporated onto stopper backings of gold and lead. The $^{36}$Ar($^{40}$Ca,2α)$^{68}$Se* reaction was used for the lifetime study of excited states in $^{68}$Se using coincident gamma-ray and charged-particle spectroscopy with the TIGRESS Integrated Plunger (TIP) device [1]. Here, we describe some of the fabrication challenges and techniques used to produce these targets.

## Materials and Methods

The preparation of the calcium targets followed our standard protocol for evaporation of reactive metals.

Gold backed targets were manufactured on thick Au foils (24 mg/cm$^2$) glued to target frames. After baking in a vacuum oven at 85 $^o$C for 10 minutes, the targets were mounted in the deposition apparatus and heated again in vacuum for 20 minutes using the tungsten evaporation boat as heat source. A gold layer of 100 µg/cm$^2$ thickness was then evaporated onto the gold backing. The chamber was vented with dry nitrogen and the targets quickly transferred into a sealed container and kept under vacuum.

After installation of a tungsten boat filled with calcium metal the targets were returned to the deposition apparatus, which was evacuated within one minute. A calcium layer of ~134 µg/cm$^2$ was evaporated onto the gold backing. The chamber was again vented with dry nitrogen. The targets were removed and stored in the vacuum container. The evaporation source was changed back to gold. The targets were reinstalled in the evaporator and a final gold layer of 19.3 µg/cm$^2$ was deposited.

Lead backed targets were prepared by the same process on 27.6 mg/cm$^2$ Pb foils coated with 100 µg/cm$^2$ of lead. A calcium layer of 250 µg/cm$^2$ was deposited and sealed with a lead layer of 20 µg/cm$^2$.

## Results and Discussion

Initial attempts to deposit calcium metal directly onto the thick gold foil failed as calcium did not bond to the surface of the unmodified backing. A freshly evaporated coating of gold was necessary to ensure good adhesion of the calcium layer. In contrast, satisfactory adhesion was achieved on thick lead foil as well as on freshly deposited lead.

It is worth noting that non-oxidized calcium targets could only be obtained by evaporation of calcium lumps but not from calcium granules.

Our experiments showed that the calcium deposits could not remain in the vented evaporator even for the short period required to change the evaporation source as they reacted visibly with moisture and air. All transfers between the evaporator and the vacuum storage vessel had to be performed swiftly to avoid oxidation of the targets.

## References

1. P. Voss, R. Henderson, C. Andreoiu et al: Nucl. Inst. Meth. A 746 (2014) 87-97

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