Preparation of ^{181}Ta and ^{182}W targets

Tathagata Banerjee[1], P. V. Laveen[2], M. Shareef[2], Abhilash S. R.[1], J. Gehlot[1],* S. Ojha[1], and D. Kabiraj[1]
[1]*Inter University Accelerator Centre, Aruna Asaf Ali Marg, New Delhi 110067, India and*
[2]*Department of Physics, Central University of Kerala, Kasaragod 671314, India*

Introduction

A target of suitable thickness is a prime requirement for a nuclear reaction experiment. For our proposed experiment at IUAC, we needed ^{181}Ta and ^{182}W targets.

Several investigators prepared tungsten targets using different techniques. Some prepared self supporting tarets by evaporating the material over a suitable substrate foil and then selectively etching the substrate in a chemical solution [1, 2]. Maier et al. [3] prepared isotopic targets by sputter deposition. Sugai et al. [4] prepared various isotopic targets using a new deposition method, based on vibrational motion of microparticles in the electrostatic field between parallel electrodes. Lipski et al.[5] heated the WO_3 powder spread on a copper (Cu) foil, in hydrogen atmosphere and later dissolved the Cu by etching.

Preparation of self-supporting ^{181}Ta targets

Self-supporting ^{181}Ta targets were prepared using the ultra-high vacuum evaporator in the Target preparation Laboratory of IUAC, New Delhi. Tantalum was evaporated using a 6 kW electron gun, on a 2 mg/cm^2 thick Cu foil, which had been made by rolling method. Cu foil was kept at a distance of 12 cm from the source during evaporation. The substrate was heated and maintained at a temperature of 300° C. Pressure in the chamber was $\sim 10^{-7}$ Torr during evaporation. Approximately 500 μg/cm^2 thick ^{181}Ta self-supporting targets were obtained after dissolving the copper substrate into the etching solution, which had been prepared with 25% HNO_3 (nitric acid) in 75 % deionized water. This method was not successful for preparing self-supporting ^{181}Ta targets thinner than 500 μg/cm^2.

FIG. 1: Rolled copper foil fixed on the substrate heater.

Preparation of carbon-backed ^{181}Ta targets

First, a 100 nm thick layer of releasing agent ($BaCl_2$) was deposited on the glass substrate by resistive heating. Then carbon layers of desired thickness were deposited over it by electron gun evaporation, using a smooth graphite rod as source. These slides were then annealed at 325° C in argon atmosphere for one hour, in order to release any stress which might have developed during deposition. These films were floated on target frames and mounted inside the ultra-high vacuum chamber for tantalum deposition. Some silver paste was applied on the sides of the films to get better conduction with the target frames, so as to protect the foils from curling. Silver would help dissipating the heat generated during evaporation,

*Electronic address: jagdishgehlot@iuac.res.in

FIG. 2: Set-up for Ta deposition.

due to high melting point of Ta (∼3295 K). However, this method was not successfull as the carbon foils did not survive Ta deposition.

So, as an alternative, the annealed carbon slides were mounted inside the ultra-high vacuum evaporator and Ta was deposited over these using an electron gun. Both films, i.e. Ta and carbon, were floated together on target frames. We succeeded in fabricating ∼200 μg/cm^2 thick ^{181}Ta targets. Pressure in the chamber was maintained at ∼10^{-7} Torr.

Preparation of carbon-backed ^{182}W targets

We had earlier fabricated ^{184}W targets on ∼100 μg/cm^2 carbon backing [6]. Probability of breaking of carbon foils in the previous method was more during the evaporation. Currently, carbon backing thickness could be minimized to ∼25 μg/cm^2, with a better surival probability. In the previous method, the maximum number of targets that could be produced in one attempt was 4-6, whereas with thin carbon backing we could fabricate ∼15 targets in one attempt. Targets of ^{182}W of thickness ∼100 μg/cm^2 could be prepared successfully. The total amount of material consumed was ∼88 mg of enriched ^{182}W.

Target Characterization

The fabricated targets were characterized for purity using Rutherford Back Scattering (RBS). Fig. 3. shows the RBS spectra for the prepared targets. It is evident that no heavy impurity is present in the targets. Presence of the carbon peak is due to carbon backing and the oxygen peak suggests oxidation of target materials. Since our experiments with these targets will be carried out in a recoil mass spectrometer, such light impurities will not cause any problem.

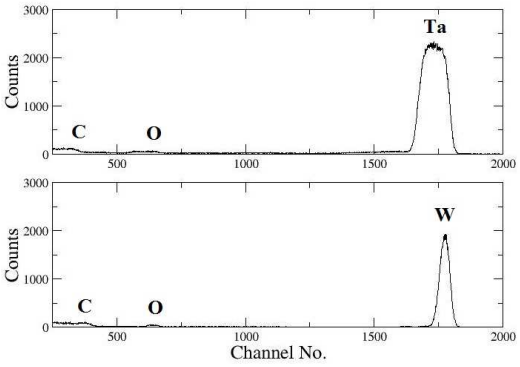

FIG. 3: RBS Spectra for prepared targets.

Acknowledgments

We thank Dr. S. Nath and Dr. E. Prasad for useful discussions.

References

[1] H. Folger et al., Nucl. Instr. and Meth. A **397**, 55 (1997).
[2] John O. Stoner Jr. et al., Nucl. Instr. and Meth. A **561**, 11 (2006).
[3] H. J. Maier et al., Nucl. Instr. and Meth. A **303**, 172 (1991).
[4] I. Sugai et al., Nucl. Instr. and Meth. A **397**, 81 (1997).
[5] A. R. Lipski et al., Nucl. Instr. and Meth. A **655**, 41 (2011).
[6] P. D. Shidling et al., Nucl. Instr. and Meth. A **590**, 79 (2008).