Thin tin (^{116}Sn) target fabrication

Nabendu Kumar Deb[1],* Kushal Kalita[1], S. R. Abhilash[2], Pankaj Kumar Giri[3], and D. Kabiraj[2]
[1]*Department of Physics, Gauhati University, Guwahati - 781014, Assam, India*
[2]*Inter University Accelerator Centre, Aruna Asaf Ali Marg, New Delhi - 110067, India and*
[3]*Centre for Applied Physics, Central University of Jharkhand, Ranchi 835205, Jharkhand, India*

Introduction

Two essential things, for the nuclear reactions to take place, are the projectile and the target. For effective results, the target thickness should be appropriate as per the requirement of experiments and its surface has to be smooth, uncontaminated and homogeneous; which, as such, poses serious challenge during its fabrication. According to the requirements, the areal density of the targets ranges from $\mu g/cm^2$ to few mg/cm^2 depending on reaction types. In order to study the transfer reaction by measuring the Evaporation Residue cross-section through Heavy Ion Recoil Analyzer (HIRA) [1] at Inter University Accelerator Center (IUAC), New Delhi, India, thin self supporting targets are highly desirable. But due to difficulties in fabricating such targets, a very thin carbon foil as a backing is required to support the target. Different means and backing composition of Sn target fabrications are already reported earlier. Refs. [2, 3] reported the self supporting Sn target prepared using rolling technique, refs. [4–7] are about the fabrication of Sn target on Au, Al, Bi and Pb-backings. In this abstract, preparation of a carbon backed thin target of 116 Sn ($\approx$ 150 $\mu g/cm^2$) isotope using physical vapor deposition technique (a thermal evaporation) has been reported. Further, the essential steps and the precautionary measures taken in successful fabrication are discussed here.

Diffusion pump based coating unit

Fig. 1 shows the picture of the diffusion pump based coating unit (DP), connected with a diffusion pump, in the target laboratory of IUAC. A piezoelectric quartz crystal-based thickness monitor was kept inside the unit to monitor deposition of thin films with time. This chamber is equipped with both electron beam bombardment assembly consisting of a single pocket electron beam gun of 2 KW (used for the carbon (C) deposition) and resistive heating evaporator (used for Sn and KCl deposition). Chilled water is circulated through the chamber to maintain them at room temperature. A liquid nitrogen trap is fitted between the chamber gate valve and diffusion pump which condense oil molecules of diffusion pump from moving towards chamber. Throughout the evaporation, the vacuum was maintained in the order of 10^{-6} mbar.

FIG. 1: The diffusion pump based coating unit

Fabrication of carbon backing

To prepare target, first step is to prepare carbon foil. For this, the chamber is thoroughly cleaned with propanol. Before going for C deposition, a parting agent (KCl) deposition is required. KCl is taken along with C source, viz., graphite and are enclosed in the chamber simultaneously. Using thermal evaporation, KCl of 120 nm thickness was de-

*Electronic address: nd_globe@yahoo.co.in

posited on the clean glass slide (as substrate) kept at 18 cm from the source. The deposition rate was around 0.1 nm/sec at around 188 A current. Following KCl, C of thickness 100 nm($\approx 25\ \mu g/cm^2$) was deposited over KCl on the slides (17 cm away from the C source) by e-gun bombardment without disturbing the vacuum. The C slides were then annealed in a tubular furnace (Fig. 2) at a temperature of 250^0C for 1 hour in the Argon gas environment to relieve the internal stress.

C-backed ^{116}Sn target fabrication

Due to the limited availability of the expensive isotope, several attempts were made to fabricate the target with natural Sn to optimize and calibrate the parameters required for the successful fabrication of isotope target. The chamber is thoroughly cleaned with propanol. 36 mg of natural Sn was taken in the annular boat of 4 cm height, fig. 2. The thickness monitor is focused at 5 cm from the source. The chamber is closed and the vacuum of around 10^{-6} mbar is obtained. Using thermal evaporation, natural Sn was then deposited on the annealed C slides, kept at 5 cm from the source, at the rate of 0.1 nm/sec at 250 A current till the desired thickness of 150 $\mu g/cm^2$ is reached. After evaporation, the chamber was left for few hours for cooling followed by venting and then the deposited material is taken out. The floating was done to separate the deposited target material from the slides by dissolving the parting agent through the slides in the warm distilled water and then it is hold by appropriate target holder. This successful fabrication of the target led us to go for the ^{116}Sn target fabrication. Keeping all the parameters same, obtained during trials, deposition was done using the same procedure. The chamber after being cooled is vented. It is opened and the floating of the deposited target was done. Floating was successful and as many as 30 targets were obtained. Fig. 2 shows some targets.

Alpha-energy loss technique

Using a strong 50 μCi radioactive ^{241}Am source, 5.486 MeV α-particle is radiated which loses its energy when they pass through the foil. Knowing the amount of the energy loss through the foil, the thickness of the target can be determined using the information of energy loss per unit length from SRIM code [8]. The target thickness is verified with this technique and is found to be in agreement with the thickness estimated from the crystal monitor, that is, $\approx 148\ \mu g/cm^2$.

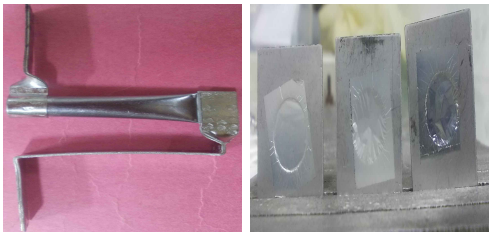

FIG. 2: Annular tube (left) and ^{116}Sn target (right)

Results and Conclusion

Thus ^{116}Sn target of ($\approx 150\ \mu g/cm^2$) thickness is successfully prepared on carbon backing of 25 $\mu g/cm^2$. Even with alpha energy loss technique, the target thickness was verified. These targets are then kept properly in the desiccator to be used for the experiments.

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