Simultaneous making of thin ^{174}Yb target on two different backings

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Introduction

Thin targets are important for nuclear physics experiments. Over decades the people have worked out various methods, like rolling method, evaporating method, electroplating methods, etc., to make such thin targets [1, 2]. Depending upon the need of the experiment and the physics to be addressed, different types of thin targets are needed. For example, A smooth, uniformly thick, easily stretchable target foils (~ 1 mg/cm^2) are required for lifetime measurement of the nuclear excited states via recoil distance Doppler shift (RDDS) method [3], while a self-supporting (preferable) or with a very thin backing of low Z material targets (thickness ~ 200 mg/cm^2) are needed for the heavy ion induced nuclear reaction dynamics studies. A particular kind of thin target requires a particular method of fabrication but many times some novel strategies have to be developed to get thin foils of desired properties. Historically, people have used the electron gun evaporation technique for making such thin targets as it is the most precise and efficient way of getting targets of high melting and boiling points with thickness < 1 mg/cm^2. In the present work we report the making of two thin targets of ^{174}Yb of different nature, on two different backings (Tantalum and Carbon) via evaporation technique at the Inter University Accelerator Center (IUAC), New Delhi. In this work, after doing many trials, thin targets of desired properties of ^{174}Yb on Tantalum backing with thickness ~ 750 μg/cm^2 and on carbon backing with thickness ~ 200 μg/cm^2 are obtained. In total ~ 50 mg of the enriched ^{174}Yb material was used in the making of these two targets simultaneously. The ^{174}Yb target on Tantalum backing has recently been used in an RDDS lifetime measurement experiment at IUAC, New Delhi. The another ^{174}Yb target on carbon backing is expected to be used in the reaction dynamics study experiment with heavy ion reaction analyzer (HIRA) [4] facility at IUAC, New Delhi, scheduled for later this year.

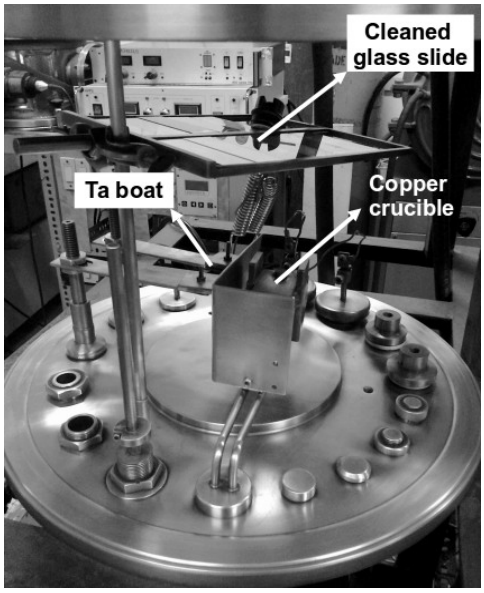

Fig. 1: A picture of HV evaporator in open position.

The experimental setup

For the preparation of these targets, the rolling machine, diffusion-pump based high vacuum (HV) evaporator (Fig. 1) and UHV evaporator (Fig. 2) at the target lab of IUAC were used. Rolling machine was used to prepare thin foils of tantalum. A HV chamber was used to prepare very thin carbon backing at the vacuum better than 10^{-6} Torr and a cryo pump based UHV evaporator was used to prepare thin target having high melting and boiling points at the vacuum better than 10^{-8} Torr. HV chamber is equipped with a 2 kW electron gun, a quartz crystal thickness monitor and also having a facility for the evaporation of resistive heating technique. The detail about the UHV evaporator can be seen in our recent publication [5]. A new substrate holder [5] was used to hold tantalum backing foils for the preparation of tantalum-backed targets.

Fabrication of carbon backing

For the preparation of thin self-supported carbon foils, $BaCl_2$ was used as a releasing agent. Firstly a layer of $BaCl_2$ of thickness 45.6 μg/cm^2 was deposited on cleaned glass slides by using the resistive heating method in HV chamber. Just after the deposition of $BaCl_2$, a carbon layer of thickness ~ 34 μg/cm^2 was deposited over $BaCl_2$ layer by using 2kW electron gun without disturbing the vacuum inside the chamber. Before floated in the hot distilled water, the carbon deposited glass slide was annealed for one hour in the presence of inert gas at a temperature of 598 K. Those floated carbon foils were used as a backing for the evaporation of carbon-backed ^{174}Yb targets.

Fabrication of ^{174}Yb targets

The available enriched ^{174}Yb was 110 mg in the oxide form. The pellet of 110 mg enriched material was put in the tantalum crucible and it was placed in one of the four pocket of copper crucible. To search the best technique for the fabrication of both tantalum and carbon-backed target with the limited amount of material, several trial had been made with natural material of ytterbium oxide. In the final evaporation, a new substrate holder with tantalum backing was kept at 5.3 cm while the substrate holder with carbon backing was kept at 7.5 cm to the material. After getting the pressure lower than 10^{-8} torr, electron gun was started and current was increased very slowly by maintaining the deposition rate 0 – 1 Å/s. After getting the desired thickness of ^{174}Yb on carbon backing, new substrate holder with tantalum foils was placed above the crucible by rotating the substrate holder with the help of knob without disturbing the vacuum inside the UHV chamber. The chamber has been evacuated in the presence of dry nitrogen.

The rough estimate of the thickness measurement has been done by using weighing machine and profilometer. The thickness of ^{174}Yb on carbon backing was found to be ~ 200 μg/cm^2 whereas the thicknesses of ^{174}Yb on tantalum backing was obtained as ~ 750 μg/cm^2. The elemental analysis and actual thickness measurement of these targets will be done by using PIXE in the cyclotron lab at Panjab University, Chandigarh.

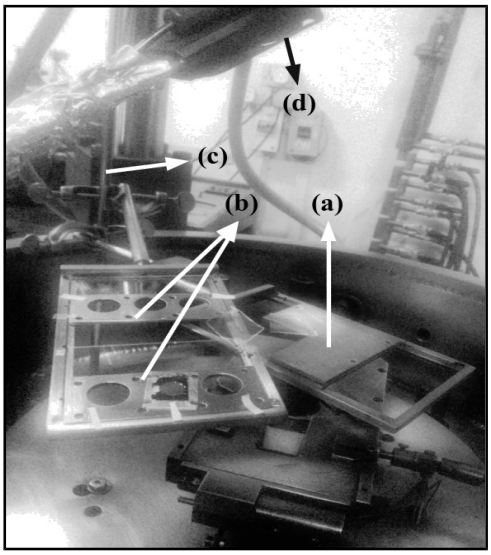

Fig. 2: A picture of UHV chamber. (a) New substrate holder, (b) floated carbon foils, (c) rotating rod and (d) quartz crystal monitor.

Conclusion

Carbon and tantalum-backed ^{174}Yb isotopic targets have been successfully prepared by using electron beam deposition method at IUAC. Only 50 mg enriched material was utilized to prepare both the targets. The tantalum-backed target has been used in the recent lifetime measurement experiment by RDDS Method at IUAC and the carbon-backed target is going to be used in HIRA at IUAC.

Acknowledgement

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References

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