Fabrication of ^{142}Nd and ^{150}Nd targets sandwiched between carbon layers

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Introduction

For understanding the reaction mechanism of heavy compound nucleus by ^{48}Ti induced reactions, we planned to measure the Evaporation Residue (ER) cross-section and spin distribution of ERs through HYbrid Recoil mass Analyzer (HYRA) [1] at Inter University Accelerator Center (IUAC), New Delhi. For this kind of study, thin self supporting targets are highly desirable. Fabrication of thin self supporting targets is highly difficult. All the attempts to make such targets in the trial session with natural neodymium (Nd) material were unsuccessful. So, it has been decided to use a very thin carbon foil ($\sim$ 15 μg/cm^2) as a backing for the purpose of minimum energy loss and energy straggling. Furthermore due to the hygroscopic nature of Nd, it quickly reacts with the hot water and form $Nd(OH)_3$. To avoid the direct contact between water and Nd during floating, a coating of very thin layer of carbon ($\sim$ 5 μg/cm^2) was also deposited [2] just after the deposition of Nd layer.

Experimental technique

Thin sandwiched ^{142,150}Nd targets have been successfully prepared by using two different techniques, electron gun bombardment and thermal evaporation technique in cryo pump based coating unit [FIG. 1] and diffusion pump based coating unit [3] respectively at the target lab of IUAC.

A. Electron gun bombardment technique in cryo based coating unit

The electron beam (6 kW) deposition technique in cryo based coating unit at IUAC, is one of the most precise and suitable method for the fabrication of targets having high melting and boiling point. It has quartz crystal monitor set-up and a copper crucible having four pockets. The important feature of this crucible is that we can make multilayer targets like sandwiched targets without disturbing the vacuum inside the chamber. Various trials have been carried out by deposition of natural Nd on annealed carbon deposited glass slides but these were not successful. In another trial, the deposition of Nd was done on dry floated carbon foils but this was also unsuccessful. After a number of trials, finally a trial was successful in which Nd was deposited on annealed carbon glass slides followed by another layer of carbon. During floating, some flakes were appeared due to the stress devel-

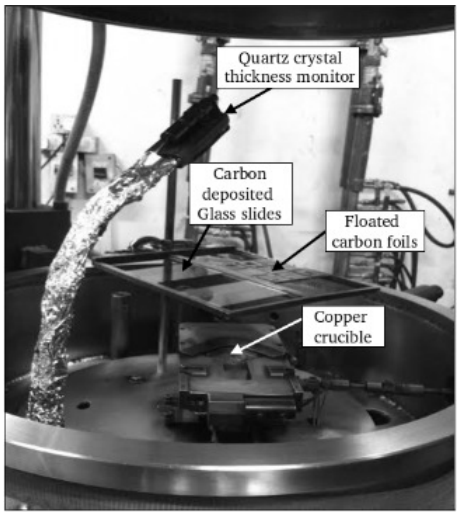

FIG. 1: Set-up used for Nd deposition on carbon deposited glass slides and carbon foils in the cryo based coating unit of IUAC, New Delhi.

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oped during evaporation. So, to reduce the stress we annealed it before floating.

In the final evaporation, 30 mg flakes of enriched ^{142,150}Nd material was put inside tantalum (Ta) crucible [FIG. 2(b)] and graphite

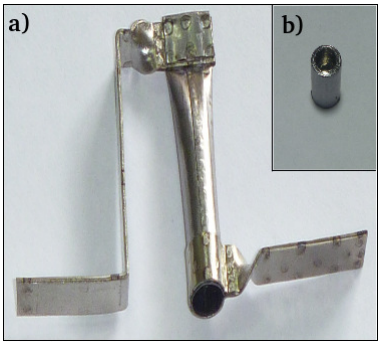

FIG. 2: a) Tantalum boat and b) tantalum crucible.

pellet was used for carbon deposition. Both the materials were placed inside the two pockets of water cooled copper crucible. Annealed carbon glass slides were mounted 8 cm above the Ta crucible. The electron gun was started when vacuum was of the order of 10^{-7} torr inside the chamber. The current was increased very slowly in such a way that the rate of deposition was maintained $\sim$ 0.1 $\mathring{A}$/sec. After getting the desired thickness ($\sim$ 200 μg/cm^2) on carbon deposited glass slides, the pockets of copper crucible were rotated for the carbon deposition and a very thin layer of carbon was deposited on the Nd layer. After this, the glass slides were annealed at 325°C for 1 hour. Finally, it was successfully floated on the target holder.

B. Thermal evaporation technique in diffusion pump based coating unit

Since the melting point of Nd (1297K) is quite less than the melting point of Ta (3290K), the resistive heating method was found to be suited for the fabrication of sandwiched Nd targets. The flakes of enriched material was put inside the Ta boat [FIG. 2(a)]. The annealed carbon deposited glass slides were fixed at a distance of 7 cm from the Ta boat. Once the pressure reached $\sim 2 \times 10^{-6}$ torr inside the chamber, the thermal evaporation process was started. The current was increased very slowly to achieve the uniform deposition. After completion of Nd deposition, the substrate holder was manually adjusted at a distance of 14 cm from the graphite pellet without disturbing the vacuum inside the chamber. After regaining the vacuum, electron gun was started for the deposition of carbon layer. Finally, targets were successfully floated in deionized hot water and were kept in argon environment in vacuum dessiccator and these are survived for more than three months.

Conclusion

Sandwiched ^{142,150}Nd targets of thicknesses $\sim$ 200 μg/cm^2 with backing and capping of carbon have been successfully prepared by using electron gun bombardment and thermal evaporation technique. These targets will be used in near future for ER cross-section and spin distribution studies in HYRA, at IUAC.

References

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