Preparation of enriched ^{176}Yb target on carbon backing

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Introduction

The study of fusion-fission reactions around the Coulomb barrier energies have been a topic of intense research during the past few decades. To study the heavy ion induced reactions, in particular fusion excitation measurements at near barrier energies, spin distribution of Evaporation Residues (ER) produced in heavy ion reaction measurements, fission fragment angular and mass distribution measurements etc., require very thin targets. Preparation of thin, isotopically enriched target is an important and challenging task in any nuclear reaction experiments. Also the storage of rare earth material targets, specifically the lanthanides targets are challenging as they are chemically very much active. Targets of ^{176}Yb were required for measuring the ER excitation functions and barrier distribution for our present interest. Self supporting thin targets were required or targets with very thin backing of low Z material were highly preferred for such studies.

The fabrication of self-supporting Yb targets has been reported by D. J. Yaraskavitch and Y. K. Peng [1].

Experimental setup

The evaporation was carried out in the diffusion pump based coating unit(high vacuum evaporator) in target laboratory of IUAC, New Delhi. During the evaporation, the vacuum was achieved and maintained in the order of 10^{-6} mbar. In this evaporator, the target material can be evaporated by resistive heating as well as by the use of a 2 kW electron gun. The former is used for the deposition of ^{176}Yb material as well as barium chloride ($BaCl_2$) whereas the latter is used for the deposition of carbon. The evaporator is also equipped with a quartz crystal thickness monitor which can give the thickness of deposition as well as the rate of evaporation on the crystal.

First step in target preparation was to prepare very thin self supported carbon foil [2,3]. For this, cleaned glass slides were used as the substarte and barium chloride ($BaCl_2$) was used as the parting agent. Glass slides were kept at 17.5 cm and 16 cm away from the resistive heating arrangement and the water cooled electron gun copper crucible respectively. After the successful deposition of the parting agent film, carbon was deposited on the slides using electron gun bombardement technique, without disturbing the vacuum inside the chamber. The thickness of the carbon foils deposited were around 30-35 μgcm^{-2}. These carbon foil glass slides were annealed in a tubular furnace to 325^{o}C for one hour in Argon gas and then cooled to room temperature in order to remove the internal stress developed in the carbon slides. During trial runs, it was found that the direct deposition of ytterbium on the carbon deposited slides were breaking while floating in warm distilled water. Also ytterbium reacts slowly with cold water and quite quickly with hot water to form ytterbium hydroxide and hydrogen gas. Therefore, the carbon foils were separated from the glass slides first by floating them in warm distilled water and taken into the respective target frames. Finally, these floated carbon target frames are placed in the

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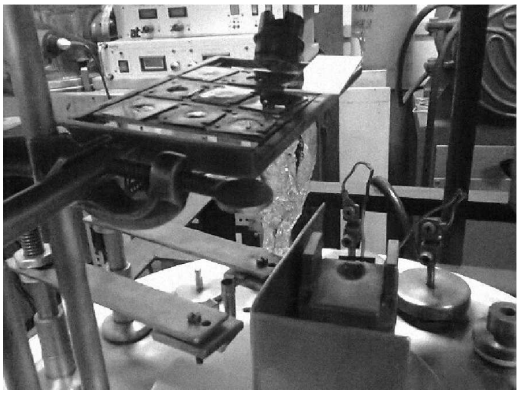

FIG. 1: The high vacuum chamber with target assembly in open position.

frame holder for the final deposition of enriched isotopic ^{176}Yb as shown in the Fig. 1.

Before depositing enriched material, trial runs were performed using natural ytterbium. These target frame holders and crystal monitor were placed above the resistive heating arrangement at a distance of 10.5 cm and 12.0 cm respectively. After arranging the carbon foil and blank peices of glass slides inside the high vacuum chamber, the chamber was evacuated to a pressure 2×10^{-6} mbar. The current was increased slowly from 0 to 85 A after the 5 minutes interval in steps of 5 A. At 85 A current the material started evaporation. The evaporation was kept very slow rate about less than 0.1 nm/sec and the current was increased more slowly upto 96 A. After the completion of evaporation of required thickness, the chamber was allowed to cool for 4 hours and later naturally vented very slowly. Target thickness was measured using profilometer also.

Result and Conclusion

Enriched ^{176}Yb targets of thickness about 150 μgcm^{-2} on carbon backing of thickness about 35 μgcm^{-2} were prepared successfully by an evaporation method. The targets were stored in Argon environment to be survived for a long duration.

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