Fabrication of ^{140,142}Ce Targets

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Introduction

Thin targets have become a necessity in nuclear physics experiments. Particularly the reaction experiments with the mass separators require very thin targets. Different techniques have been developed for the fabrication of these targets [1,2]. In the present paper we are reporting the procedure for fabrication of thin Cerium isotopes. These targets were prepared through the vacuum deposition of Cerium on thin carbon backing.

Experimental procedure

The fabrication was carried out using the Ultra high vacuum setup at the target development lab at IUAC, New Delhi. The Enriched isotopes of rare-earths are usually available in the form of oxides. These are to be reduced to the metallic form. But for our study, the experiment was to be performed using HYRA [3] facility. Since HYRA can easily separate the desired reaction products from the other contaminants, so we have fabricated the targets in the oxide form. The enriched isotopes are quite expensive, so natural Cerium oxide was used for the taking the trials at different conditions to optimize the conditions for the final deposition. The high vacuum chamber, with a vacuum of the order of 10^{-6} Torr was used for the deposition of carbon backing and Ultra High Vacuum (UHV) chamber, with a vacuum of the order of 10^{-8} Torr was used for the deposition of Cerium isotopes. The detailed procedure followed for the deposition is described as follows.

Preparation of Carbon foils

The carbon foils were fabricated in the high vacuum unit. $BaCl_2$ (taken in the form of a pellet) was used as the parting reagent. 100 nm of $BaCl_2$ layer was deposited on cleaned glass slides, kept at 17 cm from the material to be submitted, through the resistive heating technique. The thickness of film was monitored using a quartz crystal thickness monitor installed inside the chamber. Without disturbing the vacuum, carbon (taken in the form of a pellet) was deposited on it using the electron gun bombardment technique. The thickness of the carbon layer was deposited was approximately 20 µg/cm^2. Figure 1 shows the inside view of the high vacuum chamber set-up for the deposition. These glass slides were annealed at 325°C for one hour in argon atmosphere to remove the stress in the carbon films (Figure 2). These carbon films were floated in warm de-ionsed water and were taken on the target frames. The target frames were then transferred to the UHV chamber.

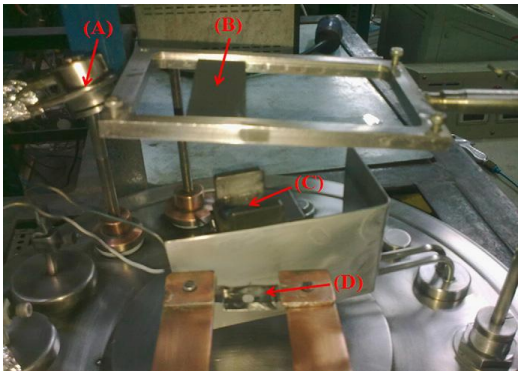

Fig. 1 Inside view of high vacuum (HV) evaporation unit: (A) quartz crystal thickness monitor, (B) glass slide placed on slide stand, (C) copper crucible containing carbon for evaporation by electron gun and (D) Mo boat containing $BaCl_2$ pellet for resistive heating.

Preparation of Cerium isotopes

The target frames with the carbon foils were placed in the UHV chamber for the deposition of

Cerium. Thickness of material deposited was monitored and controlled using a quartz crystal monitor. As discussed earlier, the isotopic material is expensive so some of the initial depositions were done with the natural material to optimize the settings and parameters. The optimized value of the distance of the carbon foils from the target material was 10 cm from the target material. For the lesser value of distance, the carbon foils got damaged.

Fig. 2 Front view of the tube furnace used for annealing of carbon glass slides.

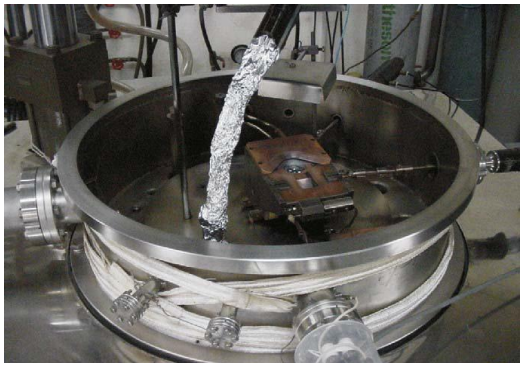

Fig. 3 Inside view of Ultra High Vacuum (UHV) evaporation unit.

During the final deposition of the oxides of the isotopes ^{140}Ce and ^{142}Ce , the initial current was kept at 30 mA to heat the material so as to release the contaminants and the trapped gases in the target material and the crucible. The shutter also kept closed to avoid any unwanted deposition on the carbon foils. Figure 3 shows the inside view of the high vacuum chamber set-up for the deposition. The final deposition was performed from 50 mA to 58 mA at the evaporation rate of 0.1 Å/s. The thickness of the targets was measured using the alpha energy loss method. The thickness of the targets was found to be around 200 µg/cm^2. These targets were used for the evaporation residue cross-section measurements using the HYRA facility.

Conclusions

Thin films of the oxides of ^{140}Ce and ^{142}Ce have been successfully fabricated through electron beam deposition method. The thickness of the targets was measured by the method using the alpha source and was found to be approximately 200 µg/cm^2.

References

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