Fabrication of thin ^{68,70}Zn target using vacuum evaporation technique

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Introduction

Preparation of uniform thin target with an isotopic purity is important for nuclear physics experiments such as in the study of nuclear reaction processes involved in the medium/heavy-ion induced reactions, synthesis of superheavy nuclei [1, 2], etc. in order to measure the physical quantities with sufficient accuracy. Depending on the physical and chemical properties of the elements, the preparation of the targets, particularly, an oxidizing material is a challenging task. For the readily oxidizing elements, it is convenient to sandwich the target between the suitable backing and capping foil which is a rather simple procedure in comparison to the use of in-vacuum transfer set-up. Carbon backing/capping is more commonly used due to minimum beam energy loss. Several less oxidizing (i.e., Ba, Er, Bi, Gd, Pb, Lu etc.) and readily oxidizing (i.e., Li, Eu, Pr, Ca) elements have been fabricated recently in the target laboratory of Inter-University Accelerator Centre (IUAC) [3, 4]. In this endeavor, the preparation of targets of two isotopes of Zinc (^{68,70}Zn) was attempted using vacuum evaporation method for the measurement of evaporation residues populated in ^{32}S-induced reaction using Heavy Ion Reaction Analyzer (HIRA) facility at IUAC.

Fabrication setup

The evaporation of enriched ^{68,70}Zn target isotopes on a thin carbon backing was achieved in the high vacuum evaporator chamber kept at $\sim 10^{-6}$ mbar pressure using a diffusion pump in the target laboratory of IUAC, New Delhi, India. The interior view of the typical fabrication set-up used for Zn target development is shown in Fig. 1. The substrate holder mounted on a linear cum rotatory manipulator was maintained at 10 cm above the Ta tabular boat containing the Zn material. A quartz crystal was kept 10 cm away from the source to monitor the target thickness and deposition rate in real time. Further verification of thickness of the target was performed using Profilometer and Rutherford backscattering spectrometry (RBS).

Fabrication procedure

First of all, the carbon backing films of 30-40 μg/cm^2 thickness were prepared on the glass slides along with KCl as a releasing agent using the electron gun technique. After that, the Zn target material was deposited on the annealed carbon slides in a high vacuum environment. The evaporation of Zn was accom-

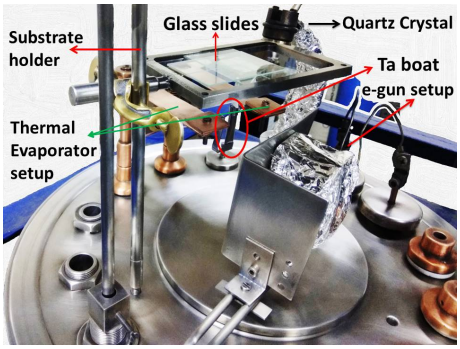

FIG. 1: Interior view of the high vacuum evaporation chamber used for thermal evaporation and electron-gun set up for the deposition of ^{68,70}Zn and ^{12}C, respectively.

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plished using thermal evaporation method due to its relatively lower melting point ($\sim$ 692.7 K). Several attempts were made using ^{nat}Zn in order to get the required target thickness with minimum target material by adjusting the distance between the substrate and source, and to fix the suitable current range for heating the Ta boat so that Zn could be evaporated gradually and uniformly.

Once the deposition of Zn was performed, the substrate holder attached with rotatory manipulator was rotated without breaking the vacuum and placed 15 cm away from the electron gun source. Finally a carbon layer of 5-10 μg/cm^2 was deposited on the Zn layer as a protective coating by the electron gun. After venting, the sandwiched Zn target was floated in the distilled hot water and mounted on an aluminium target holder as shown in Fig 2(a),(b). Fig 2(c) and (d) show the oxidized Zn strip and dark shiny slate gray Zn strip in which oxidation was hindered, respectively. The material consumption was varying from $\sim$ 35–45 mg. Due to backing and encapsulation by protective capping, the targets were stable for several months.

Characterization of Zinc foils

In the quest of purity and thickness measurement of the target foils, the characterization of Zn foils was performed using Profilometer and RBS at IUAC. In RBS, the 2 MeV α beam was bombarded on the Zn and back-scattered α-particles were detected by a silicon surface barrier detector (SSBD). The

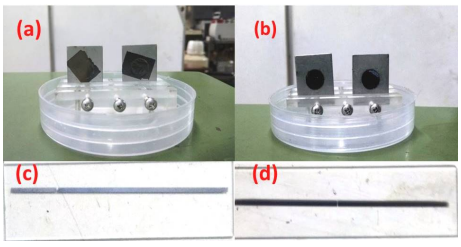

FIG. 2: Front (a) and rear (b) view of prepared ^{70}Zn targets using C backing and capping by vacuum evaporation method, and sampled ^{70}Zn strip with (c) and without (d) oxidation.

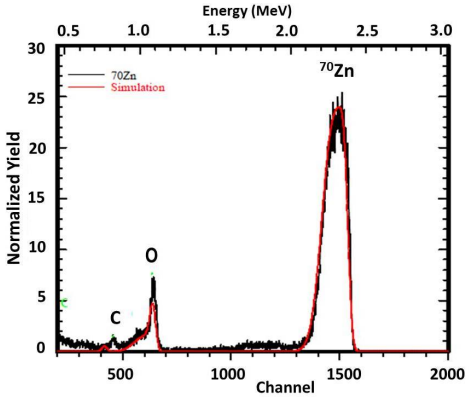

FIG. 3: RBS spectrum of ^{70}Zn target.

thickness and composition of the targets ware determined by the Gaussian fitting of the RBS spectrum as shown in Fig. 3. It is evident that no other elements are present in the target except carbon and oxygen which can be due to backing/capping and oxidation of the target, respectively. The thickness of the ^{70}Zn target estimated from the RBS analysis shown in Fig. 3 was $\sim$120 μg/cm^2.

Conclusion

Preparation and protection of the oxidizing ^{68,70}Zn target by sandwiching with the thin carbon layer were successfully achieved in a single run. Thin uniform targets free from metallic contaminants were prepared with the minimum material loss which makes this procedure useful for expensive target materials.

Acknowledgments

Fellowships from the MHRD, Government of India is gratefully acknowledged.

References

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