Fabrication of sandwiched thin targets of isotopically enriched ^{144}Sm using evaporation technique

Kavita Rani[1],* B.R.Behera[1], Abhilash S.R.[2], G.R. Umapathy[2], and D. Kabiraj[2]
[1]*Department of Physics, Panjab University, Chandigarh-160014, INDIA and*
[2]*Inter University Accelerator Centre, Aruna Asaf Ali Marg, New Delhi - 110067, INDIA*

Introduction

In nuclear physics experiments, the fabrication of the targets of the desirable thickness is one of the crucial pre-experimental work. Different kind of measurements like quasi-elastic (QE) excitation function, evaporation residue excitation function, fission fragment mass distribution etc are performed by us and each study requires different target thickness. To measure the QE excitation function and its BD, thin and uniform self supporting targets are required. The reason is any energy loss in the target thickness will tend to change the energy definition of the incident beam as well as the resolution of the energy spectra of the reaction products. For the case of lanthanides, it is difficult to prepare self-supporting targets due to their highly oxidising and chemically active nature. Hence, the sandwiched thin films of samarium are successfully prepared with carbon as backing and capping layer[1, 2] for carrying out QE measurements.

We have performed a quasi-elastic experiment at IUAC, New Delhi using HYTAR[3] detecting system and ^{28}Si beam from pelletron accelerator in General Purpose Scattering Chamber(GPSC). The sandwiched isotopically enriched thin targets of samarium were prepared using resistive heating technique.

Experimental Set-Up

To fabricate the thin sandwiched targets, the in-house facility of IUAC : a turbo-pump based high-vacuum evaporator has been employed.It consist of a 4-pocket electron gun

*Electronic address: `kavita.arora298@gmail.com`

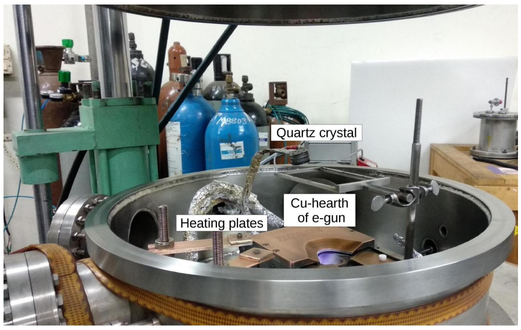

FIG. 1: Inside View of High vacuum Evaporator.

with 8kW power supply. The resistive heating plate set up inside the chamber was done to carry out the thermal evaporation as per our requirement. For carrying out the online thickness measurements, a quartz crystal monitor connected to a deposition controller is present inside the evaporator. The evaporator has a strong pumping facility consisting of a scroll pump and two turbo pumps are employed to acquire high vacumm of the order 10^{-7} mbar. Typical vacuum level 10^{-7} mbar can be maintained throughout multiple layers deposition of thin films onto the substrate material. Chilled water is circulated through the chamber to maintain them at room temperature. The inside view of the chamber is shown in Fig. 1.

Backing Preparation

For the deposition of the multilayers, ultrasonically cleaned glass slides were used as a substrate. A water soluble parting agent such as KCl or $BaCl_2$ can be used to have an effective removal of C-Sm-C layer from the glass slide. We have used KCl as a parting agent. Pellets of KCl were prepared using the hydraulic press. For the deposition of KCl and C consecutively, KCl pellets and C which was in the form of square (1cm×1cm dimensions) were placed in water cooled Cu crucibles of electron gun set up. These crucibles are rotatable through an external feedthrough capable of giving the angular motion to the crucible. For both the deposition, electron gun technique has been used. Roughly 100nm of KCl and of C over the KCl layer by the electron-gun bombardment technique was carried out without disturbing the vacuum.

Target Preparation

Before isotopic deposition, the prepared backing carbon slides were annealed using a tubular furnace at temperature of 325°C in dry argon environment for a period of 60 min to remove any stress. The material was placed in a Tantulum(Ta) boat which was placed between the resistive heating plates. A C-Piece was also placed in Cu crucible of the electron gun arrangement for the capping layer. To have a uniform deposition with least contamination, the current was ramped up gradually with slight disturbance in the vacuum. The required thickness(100-150ug/cm 2) of samarium was deposited successfully by monitoring online though quartz crystal.

After the successful deposition of the material,the glass slides were rotated over the carbon containg Cu-crucible of electron gun through a rotatable external feedthrough which can give the angular motion and the capping deposition of C was done. The chamber was vented with dry argon gas to avoid any air contact. After the deposition, the deposited material was placed for the annealing at the temperature 325°C to reduce the stress in the multilayered foil. The annealed slides were floated in the cold distilled water. The thickness of the films prepared was measured by profilometer.

Thickness and Purity Evaluation

The Thickness and purity of the prepared samples was estimated by the characterisation with RBS facility of IUAC, New Delhi. The thickness obtained for the targets are in the range of 100-150 $\mu g/cm^2$. The spectra obtained for one of the sandwiched ^{144}Sm targets is shown in Fig. 2. It clearly shows that the contents of oxygen are very negligible.

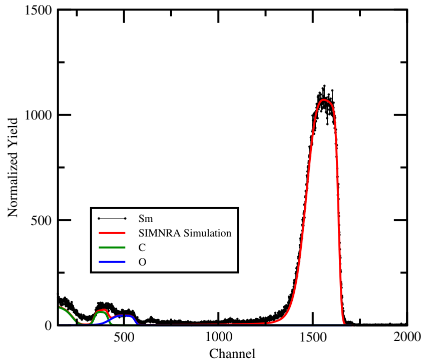

FIG. 2: RBS Spectra of one of the ^{144}Sm target simulted by SIMNRA software.

Conclusion

Sandwiched thin targets of enriched ^{144}Sm are successfully fabricated using thermal evaporation technique. The characterisation done shows the purity and thickness as per the requirement of the nuclear experimental work.

Acknowledgement

The authors are grateful to Director, IUAC for providing facilities for carrying out all the mentioned work and are thankful to Mr. Sunil Ojha for his support. One of the author Kavita Rani acknowledges the financial support from DST-INSPIRE for the research work.

References

[1] M.M. Hosamani et al.,JINST 14 (2019) P01007

[2] P. Sharma et al., Nuclear Inst. and Methods in Physics Research, A 935 (2019) 6568

[3] A. Jhingan et al., Nuclear Inst. and Methods in Physics Research, A 903 (2018) 326334.