Prepration of isotopic ^{144,154}Sm targets sandwiched between carbon layers.

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Introduction

For carrying out precise nuclear physics reaction experiments at low energy, thin targets with uniform thickness are required. The isotopic samarium (Sm) targets (^{144,154}Sm) in the range of 150 - 250 μg/cm^2 are required for one of our proposed experiments for the study of the effect of neutron shell closure on fission dynamics. Measurement of neutron multiplicity and evaporation residue cross-section is planned with the IUAC Pelletron + LINAC facility with these Sm targets.

Prepration and storage of lanthanide targets is quite challenging task as they are chemically very active. Fabrication of self supporting Sm targets has been reported by A.R. Lipski [1]. F. Nickel et al. [2] reported preparation of 100 - 500 μg/cm^2 of Sm targets with thick carbon (C) coating on both sides to prevent oxidation. In this paper, we describe an improved method for preparation of ^{144,154}Sm target of thickness 150 μg/cm^2 sandwiched between two C layers of thickness 25 and 10 μg/cm^2.

Experimental set up

Diffusion pump based coating unit [3] (High Vacuum Evaporator, HV) at IUAC, New Delhi was used for the deposition of Sm as well as C. The vacuum was achieved and maintained in the range of 10^{-6} mbar. ^{12}C was deposited using electron gun whereas for Sm resisitive heating method was used. The preparation procedure of isotopic Sm target mainly includes fabrication of carbon backing foils and fabrication of natural Sm on carbon to perfect the method.

(i) Fabrication of carbon foils

In carbon foil fabrication, cleaned glass slides were used as substrates and $BaCl_2$ was used as the parting agent. The cleaned glass slides were kept inside the vacuum chamber at a distance of 17 cm away from the electron gun. Prior to carbon deposition, $BaCl_2$ of 100 nm thickness was deposited on the glass slides by the resistive heating method. After depositing the releasing agent, C was deposited over the $BaCl_2$ by 2 kW electron gun bombardment without disturbing the vacuum. C deposited on the glass slides were annealed in a tubular furnace at a temperature of 325°C for a period of 60 minutes in the environment of dry argon gas.

(ii) Sandwiched Targets

As Sm is highly oxidizing material, so we decided to protect it by using capping of C layer. Trials were taken with natural material of Sm which is in pellet form. In HV chamber, annealed C glass slides were used at a distance of 7 cm from the tantalum (Ta) boat containing Sm material. After the vacuum was reached up to 1.8 - 2.0 $\times$ 10^{-6} mbar, Sm was deposited by thermal evaporation. Current and voltage were in the range of 115 - 120 A and 1 V. Without disturbing the vacuum, manually substrate holder was adjusted above the graphite pellet through a rotatable feedthrough at distance of 14 cm. After some time when vacuum was regained, electron gun was used to deposit capping of C layer of areal thickness 5 - 10 μg/cm^2. The experimental arrangement is depicted in Fig. 1. After this, the chamber was left for 7 - 8 hours. The first

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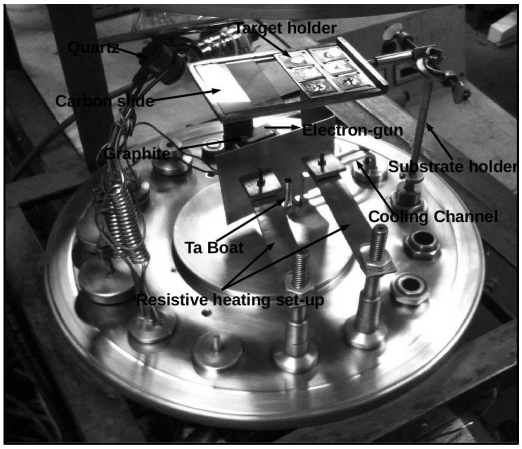

FIG. 1: Inside view of High Vacuum Chamber at IUAC depicting resistive heating and electron gun set up for deposition of ^{144,154}Sm and ^{12}C respectively.

trial was not successfull as the layers started peeling off due to over deposition of Sm material. So, in next trial less amount of Sm was deposited with capping of C. After repeating the same procedure, $BaCl_2$ layer was dissolved with distilled warm water to get sandwiched targets of Sm. With profilometer, thickness of Sm was found to be 240 μg/cm^2 and that of C capping was 15 - 20 μg/cm^2. In another trial, thickness of Sm and C capping were reduced. This time Sm thickness was found to be 170 - 230 μg/cm^2 and that of C capping was 10 - 15 μg/cm^2. Accordingly after setting all the parameters, we have finally deposited the enriched ^{144,154}Sm material. The parting agent ($BaCl_2$) was dissolved with distilled warm water to get set of six sandwiched targets of ^{144,154}Sm.

(iii) An Alternate Method

In this method, the annealed C slides were kept in warm water to dissolve the $BaCl_2$ layer. The floated C were then taken on the target holder and kept just above the Ta boat containing Sm material at a distance of 9 cm. Sm was then deposited over the target holder containing C by resistive heating method. After depositing Sm, the substrate holder was manually moved just above the graphite pellet through rotatable feedthrough to deposit a layer of C capping by electron gun method. This method also successfully produced a set of six targets.

Conclusion

Enriched (98.89 % ^{154}Sm and 93.7 % ^{144}Sm) targets, sandwiched between two C layers were prepared successfully as depicted in Fig. 2. To

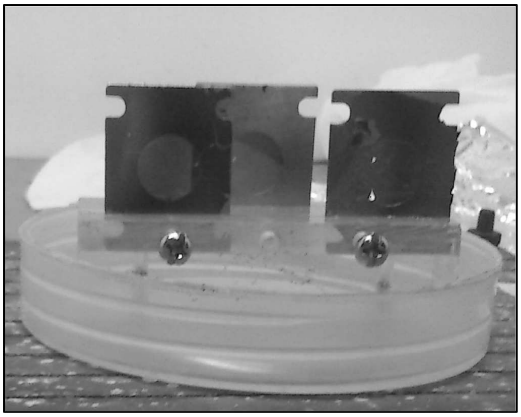

FIG. 2: Set of enriched ^{144,154}Sm targets.

confirm the survival of the targets against oxidation, targets were kept in atmosphere for a period of 2 days. The targets were stored in argon environment and they survived for a long period of 3 months. Recently, an experiment for measurement of barrier distribution for the reaction ^{28}Si+^{154}Sm has been carried out successfully at GPSC, in IUAC New Delhi with these targets.

Acknoledgment

One of the authors (RM) wants to acknowledge financial support from University Grants Commission(UGC), India in the form of research fellowship.

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