Preparation of Thin Gd^{160} Target Using Evaporation Technique

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Introduction

Target fabrication plays a very important role in the nuclear physics experiments. The nuclear physics experiments require targets with varying areal density in the range of $\mu g/cm^2$ to a few mg/cm^2. It is desirable to prepare thin films that are self-supporting so that any extraneous support material will not interfere with the experimental measurements [1]. In one of our proposed experiments to study fusion-fission dynamics, we require thin Gd^{160} as target. Keeping in mind the energy straggling of the fission fragments in the target and high cost of the isotopic materials, we decided to make thin targets of Gd^{160}. The preparation and storage of gadolinium is quiet challenging as it is chemically very active. In the literature, few reports are available on the fabrication of Gd targets. An enriched Gd^{160} of 632 $\mu g/cm^2$ on a tantalum backing of 1 mg/cm^2 had been prepared in an ultra high vacuum environment by the reduction distillation method at Inter University Accelerator Centre (IUAC) [2]. To the best of our knowledge, the thermal evaporation technique has not yet been employed for the fabrication of Gd targets. In the present work, we first tried the electron bombardment technique but it did not worked well and we switched to thermal evaporation method. Using thermal evaporation technique, we are able to fabricate thin Gd^{160} targets using 30 mg of metal pellet of Gd^{160}. A detailed description of the apparatus and method used for the fabrication of targets is presented in the next section.

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Experimental Details

The evaporation of Gd^{160} was carried out in Diffusion pump based coating unit (high vacuum system) at IUAC, New Delhi [3]. The setup is equipped with a resistive heating evaporator assembly and electron beam bombardment assembly which consist of a single pocket electron Beam gun of 2 KW. A quartz crystal thickness monitor was used for monitoring the rate of evaporation and the thickness of deposition. Fig. 1 shows the schematic of the high vacuum system and Fig. 2 shows the inside view of evaporation assembly. Before the fabrication of isotopic targets, many trials were first taken with natural Gd to optimize the parameters. Firstly, the parting reagent, Barium Chloride ($BaCl_2$) of 147 nm thickness was deposited on a clean glass slide kept at 18 cm from source by resistive heating technique. The deposition rate was kept at 0.1 nm/sec. After depositing the releasing agent, carbon was deposited

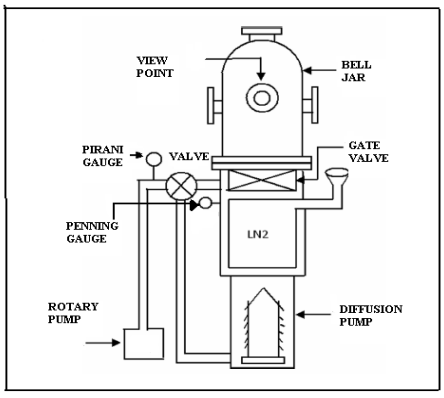

FIG. 1: Schematic of inside view of high vacuum system.

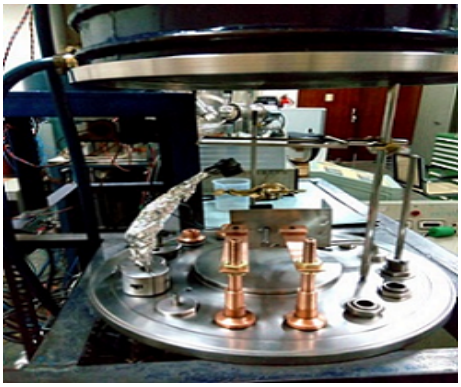

FIG. 2: Inside view of evaporation assembly at IUAC, New Delhi.

FIG. 3: Tube furnace used for annealing at IUAC, New Delhi.

over the $BaCl_2$ by electron gun bombardment without disturbing the vacuum. The carbon deposited 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 nitrogen to relieve the internal stress before separating the film from the slides. Fig. 3 represents the furnace tube used for annealing the deposited films. Gd^{160} was deposited on the annealed carbon glass slides which were kept at 15 cm from the source. Gadolinium was deposited at the rate of 0.1 nm/sec at 224 A current through thermal evaporation. For the carbon capping, the substrate holder was then rotated through 30° to shift it from Gd source to carbon source. The rotary movement of the substrate was done using rotary motion feed through. A capping thickness of about 10 $\mu g/cm^2$ was achieved. After evaporation, the chamber was left for few hours for cooling and vented in argon gas environment. The floating was done quickly to minimise the oxidation of the gadolinium thin films. The prepared targets were shifted to a desiccator in argon environment.

Conclusion

Using the above described method, we successfully prepared Gd^{160} of $50\mu g/cm^2$ thickness on carbon backing of 20 $\mu g/cm^2$ and with a capping of carbon of 10 $\mu g/cm^2$. These targets are kept in argon environment and will be used for our proposed experiment in near future.

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