FABRICATION OF THIN TARGET OF ^{138}Ba BY VACUUM EVAPORATION.

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Introduction

Target fabrication is a highly sophisticated and crucial step in nuclear physics experiments. The success of any nuclear experiment is primarily determined by the quality and quantity of the target. ^{138}Ba target is prepared for the evaporation residue cross section measurement of ^{188}Pt populated through the reaction with ^{50}Ti ion beam. Barium is a highly reactive metal and upon exposure to air at room temperature it will readily react with oxygen. Presently no information is available in the literature for the thin barium target fabrication through vacuum evaporation method. The two previous attempts available in literature [1, 2] were in sputtering method using barium nitrate or barium carbonate.

Experimental Set up

A diffusion pump based coating unit at IUAC, NewDelhi was used for target fabrication. It can provide a pressure of the order of 10^{-7}mbar. It is equipped with a resistive heating evaporator assembly and electron beam bombardment assembly side by side. In order to make the films of uniform thickness the deposition rate has to be kept as low as possible. So it is essential to monitor the thickness of the film being deposited and hence a quartz crystal monitor is used for this purpose. Chances are high that the oil particles from the diffusion pump may contaminate the target surface while operation [3]. So a liquid nitrogen (LN2) cold trap is incorporated to isolate the bell jar from diffusion pump as shown in figure1.

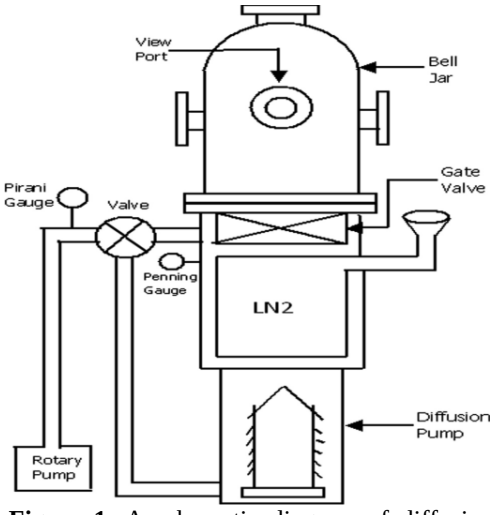

Figure 1. A schematic diagram of diffusion pump based coating unit at IUAC.

Target Fabrication

Thin targets are generally fabricated on a carbon backing with barium chloride or teepol as parting agent. The very high reactivity of barium towards oxygen demanded a capping. The following steps are followed in the target making. 1) deposition of $BaCl_2$ as parting agent on a glass substrate 2) deposition of carbon over $BaCl_2$ 3) deposition of ^{138}Ba metal over carbon backing and 4) deposition of carbon over ^{138}Ba as capping.

A thick graphite rod of length 8mm and diameter 6mm was irradiated with electron

beam to produce carbon films. This way we produced carbon films of thickness varying from 20μg/cm^2 to 52μg/cm^2. The thickness of the carbon film was verified by alpha energy loss method with the help of a ^{241}Am alpha source.

The carbon capping on the barium was done without disturbing the vacuum because of its high reactivity. For maximum deposition of the barium, the distance between the substrate holder and the source must be minimum and for carbon deposition it must be maximum to keep the barium deposited slides safe from the high melting point of the carbon. Barium evaporation was done with resistive heating method and carbon evaporation by electron beam bombardment.

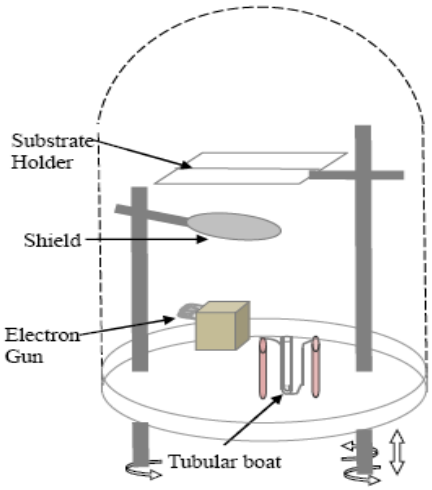

Figure 2. Electron gun assembly and resistive heating assembly of the diffusion pump based coating unit.

A tantalum tubular boat was used for the evaporation of 33.23mg of barium metal. The deposition rate in the detector was initially null until around 80A current and became quick at around 100A and after that it was almost a constant till 150A. Throughout the process the pressure was maintained around 10^{-7}mbar. Since the deposition rate was kept as minimum as possible, it took almost 8 hours for the deposition to complete at 1.0V potential difference.

For the carbon capping the substrate holder was rotated through 30 degrees to shift it from barium source to carbon source. Then it was raised by 2.5cm to protect the barium deposited plane glass slide from high melting point of carbon. The longitudinal movement and rotary movement of the substrate was done by a rotary motion feed through. A shutter or shield was also used to control the deposition. A capping thickness of about 10μg/cm^2 was achieved in about 45minutes. The vacuum chamber was vented with argon gas before it was opened and the slides were annealed at 325°C for an hour to remove any stress developed. It was floated in warm water at 53°C and was taken on target holders. The floating was done quickly to minimise the reaction with water. The eight targets so prepared were shifted to a desiccator in argon environment. The thickness of these ^{138}Ba metal targets were found to be varying from 200μg/cm^2 to 240μg/cm^2 .

References

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