Fabrication of thin Al-Foils using Vacuum Evaporation Technique

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Introduction

Earlier existing studies reveal that Excitation Function (EF) and Forward Recoil Range Distribution (FRRD) Measurements is the sensitive probe to extract the information regarding various entrance channel parameter effects on incomplete fusion reaction dynamics at intermediate energies [1-2]. As, it is well established that ICF process starts competing with CF process at energies just above the Coulomb barrier and its influence increases with increasing the projectile energies. In order to understand the reaction mechanism of complete (CF) and incomplete fusion dynamics, we have planned to measure the excitation functions (EFs) and recoil range distribution (RRDs) of evaporation residues using stacked foil activation technique. These experiments will be performed using OFF-Line measurement techniques in General Purpose Scattering Chamber (GPSC) at Inter University Accelerator (IUAC), New Delhi. The evaporation residues produced in the projectile-target interactions will be captured in the stopping medium. In present planned experiments, Al-foils will be used as stopping medium to trap the recoiling residues as energy degraders as well as catchers. Generally, aluminum is used as backing material for the preparation of non-self supporting targets, for light and heavy-ion induced reactions. The basic reason behind using the Al-catcher foils is that the background activities produced with aluminum is low. Hence, the yield of evaporation residues produced must be known precisely, especially in off-beam experiments, where the Al-foils are used as stopping medium to trap the evaporation residues with different targets. For EFs measurement, thick Al-foils are required to stop the evaporation residues completely, while in case of FRRD measurement, thin Al-catchers are required. Thick Al-foils used as degraders for EFs measurement are prepared by rolling machine technique of thickness ranging from 1.2-2.5 mg/cm^2. On the other hand, the fabrication of thin Al-catcher foils of high uniformity and required thickness around 50µg/cm^2 was not possible by using the rolling machine. For the preparation of thin Al-catcher foil, the vacuum evaporation technique was adopted. In the present work, the fabrication of thin Al-catcher foils was successfully carried out by using the vacuum evaporation is being reported.

Experimental Setup

A roughing and diffusion pump based evaporating unit, which can attain a vacuum of the order of 10^{-6} mbar in the target laboratory of IUAC, New Delhi was used for the preparation of the thin Al-catcher foils. A pictorial view of the high vacuum based target fabrication setup is shown in Fig. 1(a). Two methods are available using this high vacuum chamber to evaporate the materials, via the electron beam bombardment or the resistive heating method. Normally the electron beam bombardment method is used for the preparation of targets of materials with high melting point and the resistive heating method is used for materials with a low melting point.The evaporator has quartz crystal monitor set up and a copper crucible having four pockets, which gives the thickness of deposited material as well as the rate of evaporation on the crystal. The important feature of this crucible is that we can make multilayer target without disturbing the vacuum inside the chamber.

Procedure of Fabrication

A suitable parting agent is an important factor for the fabrication of thin depositing materials, which can facilitate the removal of a depositing material film from the substrate after deposition. Teepol was found to be suitable as a parting agent. In the first step, we have taken glass slides, which were cleaned by using different solvents, and then coated a very thin layer of Teepol on glass slides. It was allowed to dry for about one hour to form a proper transparent layer on the glass slide. The distance between the source and substrate plays an important role in minimizing the loss of material and to achieve the required thickness. Teepol coated glass slides were mounted 7.0 cm above the Tungsten filament in the vacuum chamber, which was used as resistive heating material. The distance between the quartz crystal and filament was also kept at 7.0 cm and shown in Fig. 1(b). Melting point was the important factor in the choice of Tungsten as resistive heating material. Its melting point (3422°C) is much higher than that of Aluminium (660.32°C). When the vacuum inside the chamber ~10^{-7} mbar (i.e. 1.08 × 10^{-7} mbar) using diffusion pump, then we started the resistive heating process. The current was increased very slowly for uniform deposition. After achieving the desired thickness of Al-material, Deposition was stopped Teepol layer coated glass slides. Once evaporation procedure was completed, the next step in the fabrication of the depositing material was the separation of the thin film from the substrate by dissolving the Teepol layer in an appropriate solvent. In present work, distilled water was used for the floating of Thin Al-film from the glass slide. The floated Al-foils of size 1.2cm × 1.2cm were mounted on the target frames having concentric holes and shown in Fig. (1c). The energy loss suffered by 5.49 MeV α particle obtained from ^{241}Am source, was used to determine the thin Al-catcher foils thickness. Finally, the thin Al-foils were kept into vacuum desiccator for preserving purpose.

The Authors are grateful to the Director, IUAC, New Delhi for providing the necessary facilities and the Vice Chancellor, CUJ, Ranchi for their encouragement during the present work.

References

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Fig. 1(a): High Vacuum Evaporation Chamber along with diffusion pump.

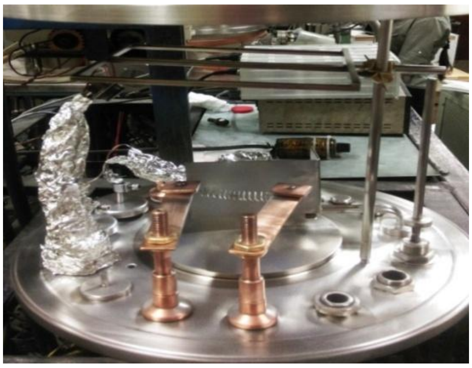

Fig. 1(b): Inner view of High Vacuum Evaporation unit.

Fig. 1(c): Fabricated thin Al-catcher foils at Target Lab, IUAC.