Preparation of ^{187}Re targets for nuclear reaction experiment

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Introduction

Preparation of thin targets for nuclear physics experiment is an important and very hectic task since it is very crucial to the success of the experiment. Usually very thin self supporting targets are required to minimize the energy loss of the reaction products. But in certain cases it is very difficult to produce self supporting thin targets. In such cases targets with very thin backing of low Z material is also preferred.

In this work ^{187}Re targets of 200μg/cm^2 thickness were prepared with a C backing of 13 μg/cm^2. The targets are prepared for the studies of energy distribution of evaporation residues (ERs) produced in the nuclear reaction experiment, using HYRA facility at IUAC. The desired thickness was 150-250 μg/cm^2 so that the ERs produced in the reaction will not be stopped within the targets. These targets are prepared using E gun evaporation method.

Richaud [1] had fabricated ^{187}Re target of thickness around 10-30mg/cm^2 on various backings. K. E. Chellis and R. K. Sheline were prepared thin ^{185,187}Re targets on carbon backings using a flow of O_2 over rhenium filaments [2]. Maier-Komor prepared rhenium targets of thickness 50 mg/cm^2 on 3 - 5 mg/cm^2 carbon backing by evaporation technique[3]. 300 mg/cm^2 rhenium targets were prepared on 100 mg/cm^2 Al backing by Demaret [4]. T Banergee [5] reported the fabrication of ^{187}Re target of thicknes 70μg/cm^2 on a C backing of 22μg/cm^2.

Experimental setup

In the present work, turbo molecular pump based coating unit (ultra high vacuum system) at Inter University Accelerator Centre (IUAC), New Delhi, India, was used for the evaporation of the target material. The details of the set up used is described in detail by T. Banerjee et al[5]. The high vacuum evaporator was used for C deposition and is shown in fig 1. The coating unit consist of a resistive heating evaporator assembly and electron beam bombardment assembly which consist of a single pocket electron Beam gun of 2 KW. A quarts based crystal monitor detector is used to monitor the rate of evaporation and thickness of deposition.

Preparation of Carbon backing

Thin layer of $BaCl_2$ is deposited on the clean glass substrate using resistive heating method. The deposition was continued till the thickness reaches 140nm. This layer will act as the releasing agent between the thin film and the glass substrate. C coating is done using E gun evaporation method on the same chamber without disturbing the vacuum. The distance between the source to substrate is 25cm and source to crystal monitor is 18cm. The rate of evaporation is 0.1nm/s. These C coated slides were annealed for 1 hour in Ar atmosphere at 325^{0}C.

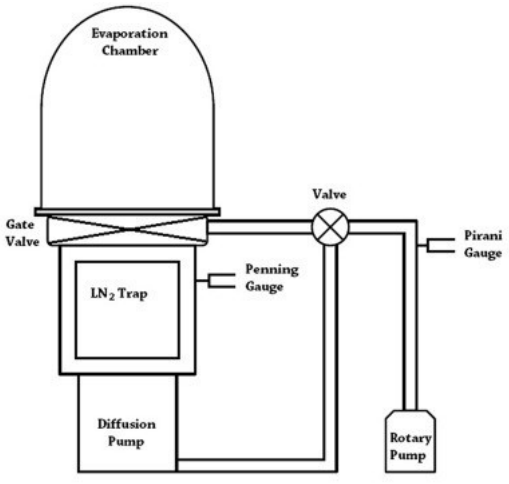

Fig 1. Schematic representation of high vacuum evaporator at IUAC.

Preparation of ^{187}Re

Several trials were performed using ^{nat}Re in order to optimise the parameters for the desired thickness. In the final deposition ^{187}Re in the powder form is converted to a pellet using a die of 3mm diameter and annealed C slides were used as the substrate. The distance between the source and the substrate was fixed as 6cm and the distance between the source and the crystal monitor was 24cm. After achieving a pressure of 1.1*10-6 torr the evaporation was started. When the beam was increased above 100mA ^{natural}Re and ^{187}Re in powder form is melted to a small metallic ball shaped object. The correct focusing of the beam on this sphere was very difficult. If it is not properly focused the deposition will not be proper and the thickness will not be uniform.

The rate of evaporation was 0.1nm/s and the evaporation current was varied slowly from 100 to 200 mA. The evaporation was continued for one hour. After evaporation the chamber was kept cooling for 6 hours. This chamber was vented in air and all the Re deposited slides were annealed again in the same condition. The targets were floated in the warm distilled water and picked on target holders. The measured thickness of the target using profilometer is 200μg/cm$^{2.}$ The inside view and schematic picture of the ultra high vacuum evaporator used for the Re coating is shown in fig 2 and 3 respectively.

Fig 2. The inside view of ultra high vacuum chamber used for enriched isotope deposition.

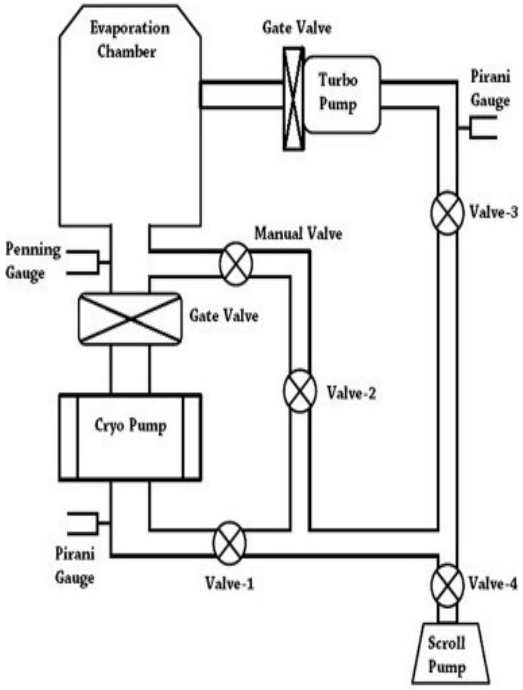

Fig 3. schematic picture of ultra high vacuum evaporator at IUAC used for isotope deposition.

Conclusion

Though Re is a high melting point (3185^{0}C) metal the preparation of ^{187}Re (thickness 200μg/cm^2) using the available material was very successful. Since the technique used for the deposition is very efficient it was able to prepare about 22 targets with 77mg of the substance.

References

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