Fabrication of ^{94}Mo Target

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Introduction

The success of nuclear physics experiments are mainly depends on the target of the isotope, which is to be studied. So preparing target plays an crucial role in success of the nuclear physics experiments . The three main techniques has been used for preparing targets are namely, (i) Chemical (ii) Mechanical and (iii) physical evaporations. Different methods used in each techniques has been discussed in detail by L. Yaffe [1] and A H F Muggleton [2]. However, the technique to be used for target preparation has been decided based on the requirement of thickness, the physical and chemical properties of the target material as well as its cost. In general, for the gamma ray spectroscopy experiments ,thick target of thickness above 3mg/cm^2 and thin-target of less than 1mg/cm^2 with high Z material backing thickness of 10 -14 mg/cm^2 such as Au , Pb...etc is good enough to stop the recoil nuclei within the material. Thick and thin target with backing has been used to study the various properties of nuclei at high spin states and the lifetimes of the excited states in the sub-picosecond range. Due to the wastage of material in evaporation technique, pack-rolling method is a preferred technique to obtain a thickness of around 1mg/cm^2 for the gamma-ray spectroscopy. In the following sections, we have discussed the preparation of self-supporting ^{94}Mo of thickness 6mg/cm^2 and target of ^{94}Mo (1.5mg/cm^2) with Au (10mg/cm^2) backing.

Target preperation

Before the fabrication of ^{94}Mo target, trial attempt has been performed with the natural Mo material. We have taken natural Mo in a powder form of about 100mg. The powder was pressed into a pellet using 3mm die set. The resulting pellet was melted using a e-gun at a pressure of 10^{-6} mbar and with the power supply of 2kW. The droplet shaped melted Mo material was placed between mirror polished folded stainless steel plate. The rolling was started with low pressure to prevent the cracks within the material. The pressure was increased gradually. The cracked edges of the material were trimmed in between the rolling in order to avoid further growing of cracking within the material. At the thickness of about 1.8 mg/cm^2 foil becomes very sticky to stainless steel plate. We used the sharp and clean pieces of paper to remove the foil very carefully from stainless steel plate rather than using forcep. Procedure is repeated after each fifteen minutes with 5 to 6 rolls. In this way we successfully reached the thickness of 1.38 mg/cm^2. Thickness is estimated by the expansion in area of foils keeping the weight fixed. Fig 1 shows the rolling machine used for the target preperation at IUAC, new delhi.

Self-supporting Target

With the several successful trial attempts, we have weighted 100 mg enriched (98.9% purity) powder of ^{94}Mo and pressed into a pellet using a die set by hydraulic press method. In order to avoid contamination, the die set was cleaned for several times using iso-propyl alcohol before making pellet. The pellet was then melted and the melted enriched material was kept inside stainless-steel plate for cold-rolling. The droplet shaped melted material was broken into 5 pieces while rolling with low pressure. One small piece of enriched material having weight of 11.3 mg has been taken out from the 5 pieces and started cold rolling. Finally, self-supporting ^{94}Mo target of thickness

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FIG. 1: Rolling machine used for the target preperation.

6mg/cm^2 has been fabricated with same procedure as in the trial attempts.

^{94}Mo target with Au Backing

Before preparing the enriched ^{94}Mo on Au target, trial attempts has been carried out with the natural Mo on Au. The melted natural Mo material was kept inside the stainless-steel plate and reduced to thickness of 3 mg/cm^2. Similarly, gold foil of thickness 44mg/cm^2 has been taken and reduced to thickness of 12mg/cm^2 after rolling of 2-3 hours. Gold foil of thickness 12mg/cm^2 and ^{94}Mo of thickness 3mg/cm^2 was kept together inside the stainless plate and was rolled for 30-45 minutes. However, the gold and ^{94}Mo foil was not sticked together. So,in the very first attempt we applied a natural indium as a sticking agent of thickness 50nm (76microgram/cm^2) on natural gold and ^{94}Mo respectively using high - vacuum evaporation technique. For this purpose, natural Mo and gold foil was taken in the glass substrate for the evaporation. Evaporation of indium on Au and Mo has been done at the voltage of 1V and 225-230 amp current with the deposition rate of 0.2-0.3nm/sec. After the evopration ,the gold and Mo foil has been taken out from the glass plate and kept together inside the steel plate for rolling. However, the foils were not sticked together after rolling. Finally, we have decided to apply 100nm thickness of indium on enriched Au and ^{94}Mo. Before the evaporation of indium , the enriched ^{94}Mo and gold has been rolled separately upto thickness of 1.5mg/cm^2 and 10.8 mg/cm^2 respectively. Both the rolled enriched materials were cleaned separately using trichloroethylene, acetone, and propyl-alcohol respectively. Then the enriched ^{94}Mo and Au was mounted on the glass-plate using silver paste at the corners.

Evaporation of indium on gold and ^{94}Mo has been performed with the same value of current, voltage and deposition rate as in the trial attempt. Then the indium deposited Au and ^{94}Mo has been taken out very carefully from the glass plate . Both the Au and ^{94}Mo was kept together in such a way that the evaporated indium side was facing each other inside the stainless steel plate and rolled with very low pressure. Finally, ^{94}Mo target(1.5mg/cm^2) on Au (10mg/cm^2) was successfully fabricated.

References

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