Fabrication of ^{54}Cr target on ^{197}Au backing

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Introduction

Study of fusion evaporation reactions throws light on nuclear structure through in beam γ- ray spectroscopy and lifetime measurements. Thick targets with thick backing materials are suitable for the spectroscopy and thin targets with thick backing of high Z materials are preferred for lifetime measurements by Doppler Shift Attenuation Method (DSAM). We are interested in both aspects of nuclear structure studies. For this reason we have decided to make a target of intermediate thickness of the order of 600-800 μg/cm^2 with a $\sim$ 12.0 mg/cm^2 ^{197}Au backing . A number of techniques e.g. electro-deposition, vacuum evaporation and ion beam sputtering are used for target fabrication.

Previously, C. A. Bouchard et al. [1] has tried to prepared Cr targets by electroplating of Cr on a copper foil and by dissolving the backing by floating on the trichloroacetic acid - ammonia - water solution. Kuehn et al. [2] has also reported the preparation of Cr isotopes by electroplating. In addition to above, G. Manente et al. [3] has reported the preparation of self-supporting Cr targets in the thickness range 0.3 to 2 μg/cm^2. The Cr bead required for rolling has been obtained by the reduction of Cr_2O_3 and the material was solidified and cleaned by resistive heating technique. The streched Cr foils was prepared as reported by Stoner [4] using electron beam deposition method which is not appropriate method for low material consumption.
This paper reports the fabrication of ^{54}Cr target on ^{197}Au backing using cryo pump based Ultra High Vacuum deposition (UHV) unit.

1. Experimental Setup

For the fabrication of ^{54}Cr target on the ^{197}Au backing the facilities rolling machine and Cryo pump based Ultra High Vacuum deposition (UHV) unit. (see Fig. 1) was used at Inter University accelerator Centre (IUAC) , Delhi. The first step is to prepare Au foils of $\sim$ 12.0 mg/cm^2 thickness using rolling machine. The initial rolling was done by using folded stainless steel pack of 6 cm wide and 7.5 cm long. As gold is a malleable metal, within a small time and rolling process the thickness of initially given gold foil was reduced to large extent. There are some chances of impurities although precautions have been taken to keep everything clean by using the propanol solution.

In order to achieve the proper thickness of Au foil intensive care was taken by trimming the edges of the foils to avoid the propagation of cracking. Also it was found that stainless steel became slacked after applying more and more pressure due to unwanted strain which is developed in the foil. In order to avoid this effect, the stainless steel sheet was heated upto 200^{0}C using a heater before starting the rolling.

In order to pepare the final target, the next step is to deposit ^{54}Cr on Au backing. It is necessory to optimize the vacuume deposition parameters of the Cryo pump based Ultra High Vacuum deposition (UHV) unit as ^{54}Cr has a very low abundance (^{54}Cr = 2.365%) and its enriched form is very costly. To achieve the deposition parameters a trial with natural ^{52}Cr on gold backing of 12.90 mg/cm^2 thickness was taken. The distance of the substrate from the tantalum crucible containing natural Cr was 6 cm and distance of quartz crystal

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from the tantalum crucible containing natural Cr was 23 cm. Deposition was carried out for 25 minutes at a rate of 0.3 Å/sec.

The maximum current was 65mA and the thickness was monitored by a quartz crystal monitor. The thickness was further verified by a profilometre. After many trials, the quality and the control on the deposition was optimised by using the natural ^{52}Cr layer by achieving the required thickness of target (natural Cr) on Au backing.

Finally, the isotropic ^{54}Cr (enrichment 99.20 percent) was taken to do the vacuum evaporation using the Cryo pump based Ultra High Vacuum deposition (UHV) unit. 98.6 mg of ^{54}Cr was taken in a tantalum crucible to do its deposition. The parameter values are kept almost constant as optimised in the above vacuum deposition with natural Cr. A glass slide was also kept beside the gold foil. The Cr deposition on glass slide was used for the thickness measurement by profilometre.

The current was increased slowly up-to 60mA. The deposition rate was kept about 0.1 Å/sec for first 25 minutes and then it was increased to 0.4 Å/sec. for next 30 minutes to achieve the desired thickness of the ^{54}Cr targets. Using the profilometre $\sim$ 500 mg/cm^2 thickness was measured for these targets. Fig. 2 shows the targets those are prepared in the above process.

The targets are now safely kept in vacuum so as to avoid any contamination and oxidation.

2. Results and Conclusions

Isotopic targets of ^{54}Cr of thickness $\sim$ 500 μg/cm^2 were prepared on ^{197}Au backing of different thickness 11.66 mg/cm^2 , 12.4 mg/cm^2, 12.5 mg/cm^2 at Inter University Accelerator Centre (IUAC), New Delhi. The electron beam deposition technique was used to fabricate these targets in Cryo pump based Ultra High Vacuum deposition (UHV) unit. and 58.9 mg material of ^{54}Cr having isotopic enrichment of 99.20 $\pm$ (0.01) was utilized in this process. Energy Dispersive X-ray fluorescence (EDXRF) technique will be used to measure thickness of target and backing material and to detect the presence of contaminants.

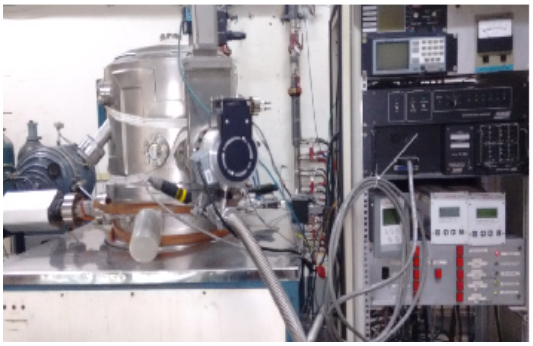

FIG. 1: (Colour Online) Outside view of UHV unit.

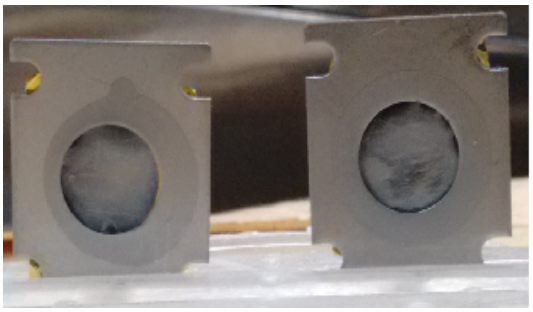

FIG. 2: (color online). Frames with ^{54}Cr on ^{197}Au backing.

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