Recent target development activities at IUAC

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Introduction

The target development laboratory at Inter-University Accelerator Centre (IUAC) is one of the main facilities for the fabrication of nuclear targets in the country. Depending upon the properties and other factors like high price and less availability of the target materials, various target preparation techniques have been developed. Targets are developed in the form of self-supporting or on suitable backing and are also capped as per requirement. Physical vapor deposition (electron gun bombardment technique and thermal evaporation technique) and mechanical rolling are the main techniques adopted for the target preparation. This laboratory has already developed methods to minimize consumption of expensive isotopic material during target fabrication [1]. Here we report methods adopted to prepare targets of elements having high melting point like W and Ta and Mo with elements available not more than 100mg [2]. Preparation, protection and preservation of targets of readily oxidizing elements like Nd, Pb, Sm, Gd and Ba is also discussed. Main focus of the report is to discuss the recent developments in different target preparation techniques for the isotopically pure nuclear targets.

Experimental procedure

a) Target preparation of oxidizing elements and preservation

Preparation and preservation of targets of readily oxidizing elements are always a challenging task. Developments of isotopic Pb, Ca and Gd targets were already reported [3,4] and further developments in preservation of such oxidizing targets were already in the process. Recently target laboratory got success in preparing targets of isotopic Pb, Nd, Ba and Sm which remain usable for longer time. In the new method, the target element was evaporated by thermal heating on the C coated glass slides with $BaCl_2$ as parting agent. After the evaporation, another thin layer of C of 5μg/cm^2 was evaporated by electron gun on the coating of target element. Since all the evaporations are done continuously in high vacuum environment without disturbing the vacuum, the target material is sealed in a carbon sandwich which protects the target material from the oxidation. After separating the target from the glass slide, it was mounted on the target frame. The targets are stored in the vacuum desiccator in Ar environment for longer life. Thick targets of Pb and Gd isotopes fabricated by rolling are also stored in Ar environment to minimize the oxidization.

b) Target preparation of materials having high melting point

Developments of isotopic W, Zr, Mo and Zr metallic targets in IUAC were already reported [2]. Thin targets of tungsten isotopes of ^{182}W, ^{184}W and ^{186}W were frequently fabricated in IUAC, but the process had drawbacks regarding the number of targets achievable in a single evaporation and the reliability of the carbon backing foil. Therefore we optimized our process. Now W was directly evaporated by electron beam on the glass slides already coated with 25μg/cm^2 of carbon and 100 nm of $BaCl_2$ as a parting agent. Before and after the evaporation of W, the carbon coated glass slides were annealed at 325^{o}C in argon environment in order to relive the stress from the foil. The glass slide having now films of W, C and $BaCl_2$ were floated in distilled water. Finally the tungsten film was mounted on a target frame. With this method more than 15 targets of ^{182}W of 100μg/cm^2 thickness were prepared in a single evaporation run by using 80 mg of material. Ta and Zr targets on carbon backing were also prepared by same procedure which was adopted for W target.

c) Improvement in the collection efficiency in vacuum evaporation

Minimizing the material wastage is important in the fabrication of targets of expensive isotopes in evaporation. If the distribution of the vapor flux is not controlled in the evaporation, large amount of material is wasted. Fig.1 shows the graphite evaporation sources developed at IUAC which is very effective in reducing the material consumption in target fabrication by vacuum evaporation method. This crucible is an assembly of a crucible body and a cap. The cap has a hole of 1-2 mm diameter. The inner volume of the crucible assembly is sufficient for accommodating a volume of 150 mm^3 of material. Crucible body and top cover are connected by thread joint. Crucibles with low internal volume of 60 mm3 are also in use for target material available in small amount. The design of the graphite crucible allows heating the material either by beam of electrons provided by electron gun or by resistant heating using tungsten basket heater. Table 1 shows the details of recent evaporations using graphite crucible. The collection efficiencies of the graphite crucible were better than the commercially available evaporation sources.

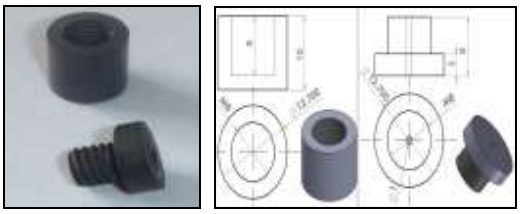

Fig.1: Graphite crucible and its dimensions

	Source-substrate distance (cm)	Mass (mg)	Thickness (mg/cm^2)
Cd	2.5	35.8	2.076
Pb	2.5	34.5	2.897
Ag	2.5	1.22	0.2499
Zn	3	2.8	0.2213
In	5	37	2.2397

Table 1: Details of evaporations by graphite crucible

Target specification	Fabrication technique
^{142,148,150}Nd, 250μg/cm^2	E-Gun/Resistive heating
^{182,184}W,100μg/cm^2	E-Gun
^{174,176}Yb, 800-150μg/cm^2	E-Gun
^{92,94}Zr,300-520μg/cm^2	E-Gun
^{154}Sm,150μg/cm^2	Resistive heating
^{204,206,208}Pb, 100-400μg/cm^2	Resistive heating
^{122,124}Sn, 250-4000μg/cm^2	Resistive heating/Rolling
^{128,130}Te,400μg/cm^2	Resistive heating
^{144}Sm,150μg/cm^2	Resistive heating
^{94}Mo,1000μg/cm^2	Rolling

Table 2: Recently fabricated targets at IUAC

Conclusion

The target development laboratory in IUAC has fabricated and supplied many targets to nuclear physics research community in India. Table.2 shows some of the recently fabricated targets in IUAC. More works have done in the direction of improving or modifying the existing process to reduce the cost and efficiency of target fabrication.

References

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