The influence of various parting agents on self-supporting targets of Zn

H. Arora[1,*], Abhilash S. R.[2], D. Kabiraj[2], G. R. Umapathy[2] , B. R. Behera[1], Amit[1] and Subodh[1]

[1]*Department of Physics, Panjab University, Chandigarh - 160014, INDIA*

[2]*Inter University Accelerator Center, Aruna Asaf Ali Marg, New Delhi – 110067, INDIA,*

** email: honeyarora3191@gmail.com*

Introduction

Zinc (Zn) is a bluish-white reactive metal having a lustrous shine to it. The melting point of Zn is quite low, i.e. 419.5 ^{0}C, so it can be easily fabricated using the resistive heating evaporation method. Thermal evaporation for ^{Nat,64}Zn to obtain thin films was performed in a bell-shaped diffusion pump based high vacuum chamber in Target Lab at Inter University Accelerator Center (IUAC), New Delhi.

The targets prepared were to be used in a nuclear fusion evaporation experiment, in which evaporation residues were detected using MWPCs kept at forward angles. For the evaporation residues formed to reach the detector, it was required that energy loss of the residues is minimum in the targets prepared. So, it was preferred to prepare self-sustaining targets of thickness around 500 μg/cm^2.

The literature available for self-supporting targets of ^{64}Zn prepared by evaporation is very limited and in those, the parting agent used is Betaine Monohydrate, which fails critically in humid environment. So, to fabricate self-supporting targets of isotopic zinc with a very limited quantity (100 mg) was indeed a challenging task. Many trials were carried out using ^{Nat}Zn to find the appropriate parting agent which would be suitable to get the thin foils of desired thickness. With this limited material, around 15 thin self-supporting targets of ^{64}Zn of various thickness (450 μg/cm^2 to 1.295 mg/cm^2) were fabricated using thermal evaporation method.

Experimental Setup

The ^{Nat,64}Zn targets were prepared in bell shaped diffusion pump based high vacuum chamber with liquid nitrogen (LN_2) trap between the chamber and the diffusion pump (Fig.1) to remove the oil contamination by diffusion pump at IUAC, New Delhi. A pressure of 2 X 10^{-7} Torr was maintained in the vacuum chamber. In this chamber, evaporation can be performed either by electron gun (2 kW) evaporation or thermal heating or both can also be used simultaneously without breaking the vacuum. In the present case, the parting agents chosen were pelletized (unless mentioned otherwise) and placed in the copper crucible. The glass slides were mounted on a frame which was connected to a movable rod, so that in-vacuum it could be rotated and hence evaporation by resistive heating could also be performed subsequently. Zn material was kept in copper crucible, which was kept in tungsten holder, this whole arrangement was connected to the copper rods which were in turn directly connected to the chamber for resistive heating. For the e-beam deposition of the parting agent, the substrate was kept at a distance of 11 cm from the source, while for the resistive heating the distance was reduced to 5 cm using the previously mentioned movable rod.

Fig. 1 Chamber used for fabrication of ^{Nat,64}Zn targets

Parting Agents

For the fabrication of isotopic Zn targets, trials were done using ^{Nat}Zn with various parting agents. Earlier few blind trials with KCl as parting agent was carried out, but it was found that the films obtained sank in water when floated and were quite difficult to be mounted on the target frame. Also, it was found that Teepol was not suitable for obtaining self-supporting Zn targets. The influence of properties of the material to be deposited on the properties of the parting agent was then studied. And it was found that; there was more likelihood of deposition and hence obtaining the free-standing targets, if both had the same crystal structure [1,2]. Taking this into consideration, as Zn has hexagonal closed pack crystal structure, the parting agents having same crystal structure were shortlisted. Various trials were carried out with the one's which were easily available and cost effective. Few of the parting agents chosen were CaI_2, $MgCl_2$ and $ZnCl_2$. CaI_2 was selected initially, it was susceptible to absorb water very rapidly from the atmosphere so an enormous care has to be taken while pelletizing it for vacuum evaporation. But it was observed that floating the targets was very unpredictable in this case, as sometimes the targets floated and at other times it was difficult to remove the deposited targets from the glass slides. $MgCl_2$ salt was in highly hydrated form and it was pelletized with great difficulty, where it left a lot of water while pelletizing. It was tried to deposit this on a glass slide by electron gun initially, but was very difficult to maintain vacuum in that case so later thermal evaporation for the same was carried out. This trial failed drastically due to the property of $MgCl_2$ to absorb water rapidly and flakes of dried $MgCl_2$ were found scattered all over the chamber after thermal evaporation.

Finally, $ZnCl_2$ was chosen as the parting agent and it was pelletized and deposited on the glass slides using the electron gun. After this Zn was deposited without breaking the vacuum carrying out evaporation by thermal heating. It was found that the targets obtained were successfully floated and hence mounted on target frame after optimizing the thickness of parting agent and Zn material to be deposited subsequently.

Characterization of Targets

The target purity and thickness were measured using various techniques such as Alpha particle energy loss technique, Energy Dispersive x-ray Spectroscopy (EDS) measurement, Rutherford backscattering (RBS) characterizations and Energy Dispersive X-ray fluorescence (EDXRF) technique. Few of the results are shown below.

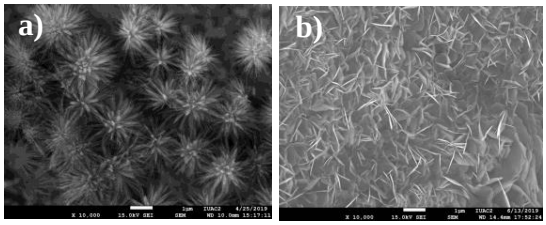

Fig.2 EDSEM Profiles with parting agents a) CaI_2 b) $ZnCl_2$

Element	Weight %	Atomic %	Error %
C K	0.02	0.08	98.69
O K	3.01	11.09	7.84
Ca K	2.34	3.44	9.36
Zn K	94.64	85.39	4.82

Element	Weight %	Atomic %	Error %
O K	4.08	14.62	11.12
Cl K	1.57	2.54	27.07
Zn K	94.35	82.83	7.66

Table 1 Results of EDS Analysis showing the purity of the obtained samples when parting agents a) CaI^2 (1^{st} table) b) $ZnCl^2$ (2^{nd} table)

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References

[1] A H F Muggleton, Vacuum **37** 785 (1987).
[2] D. N. Braski, NIM **102** 553 (1972).