# Preparation of thin targets of volatile $^{64}$Zn and $^{68}$Zn

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## Introduction

The thin film fabrication of volatile elements, viz. Zn, Cd, has been a tedious task and their vapor condensation require specialized techniques. For preparation of zinc targets, Muggleton [1] suggested reduction of ZnO. The proximity of ZnO reduction temperature to the boiling point of zinc poses an explosion risk. Zinc has a low vapor pressure at evaporation temperature making condensation of its vapors on a substrate difficult. To enforce the condensation of zinc vapor Maier [2] used substrate cooling with liquid nitrogen while Salem [3] used a glass enclosure. High substrate temperatures could lead to re-evaporation of zinc, making film deposition difficult. Zinc, being a reactive metal, makes oxidation of the films unavoidable when exposed to air. The separation of zinc films from the substrate using traditional warm water floating method could deteriorate the film. Carbon backed targets of $^{64,68}$Zn of thickness around 200 $\mu$g/cm$^2$ were fabricated [4] at Inter-University Accelerator Center (IUAC), New Delhi. The targets were successfully used in measurements of fusion excitation functions in interactions of $^{19}$F $^{64,68}$Zn.

## Fabrication of $^{64,68}$Zn targets

For the deposition of zinc, carbon coated glass slides were used as substrate with $BaCl_2$ as the releasing agent (chosen because of its high solubility in water). A 10 $\mu$g/cm$^2$ film of $BaCl_2$ was deposited on glass slides via resistive heating. On $BaCl_2$ film, a 10 $\mu$g/cm$^2$ film of carbon was deposited using an electron gun. The slides were than annealed at 350°C in an argon environment to remove stress.

The fabrication of zinc targets was achieved via resistive heating in a high vacuum environment, produced using a diffusion pump facilitated with a liquid nitrogen trap [5]. To generate needful zinc vapor pressure, the material (zinc) was kept in a carbon crucible having a pinhole which acted as a point source and enhanced the collection efficiency. A number of evaporation trials were performed using $^{nat}$Zn to optimize (a) the heating current, (b) the source to substrate separation to minimize substrate heating, and (c) the time duration of evaporation to achieve the required thickness of the films. After evaporation, the carbon coated glass substrate were floated in warm water to separate the zinc films. It resulted in the degradation of the films which was possible outcome of zinc reacting with water. Next, to prevent contact of zinc with water, the evaporation was performed upon carbon films mounted on aluminum frames. It resulted in usable films of thickness around 200 $\mu$g/cm$^2$. The optimized current was 5 $A$, the source to substrate separation 6 $cm$, and the evaporation duration around $12-15$ minutes. A number of usable targets were produced with enriched $^{64,68}$Zn and immediately stored in an argon environment.

## Characterization of zinc targets

The thickness of the produced $^{64,68}$Zn targets was estimated using the $\alpha$ particle energy loss technique. Fig. 1 shows the spectrum of the $\alpha$ particle source $^{241}$Am throgh blank aluminium frame in comparison to the alpha particles after passing through carbon backed $^{64}$Zn film. The thickness of targets were found to be in the range 150 $\mu$g/cm$^2$ to 270 $\mu$g/cm$^2$. Rutherford back-scattering (RBS) was performed using 1.7 MV 5 SDH-

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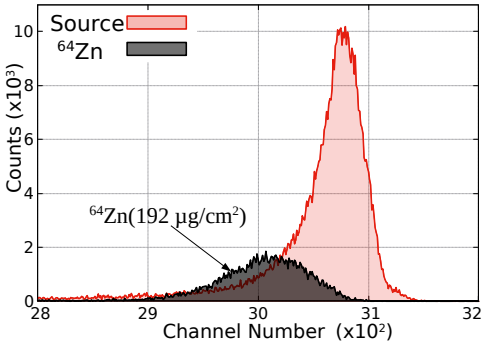


FIG. 1: . $\alpha$ particle energy spectra showing energy loss in the carbon backed $^{64}$Zn target of thickness 192 $\mu$g/cm$^2$.

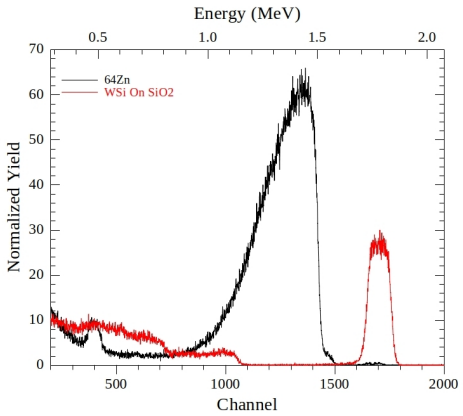


FIG. 2: RBS spectrum of $^{64}$Zn and WSi on $SiO_2$.

2 Pelletron accelerator at IUAC. Fig.2 shows the RBS spectrum of $^{64}$Zn obtained using XRUMP. WSi on $SiO_2$ was used for calibration. The thickness calculated from the RBS data was similar to that from the $\alpha$ energy loss method. The RBS data showed traces of oxygen in both the targets; as a result of oxidation of zinc. No other significant contamination was observed. SEM characterization of the zinc films was performed to investigate the film morphology. Porosity and texture in the films was observed from the SEM images. Fig.3 shows the SEM images of $^{64}$Zn before and after irradiation with $^{19}$F ions. The zinc atoms tend to coalesce and increase in volume as a result of ion-induced lattice defect mediated diffusion [6].

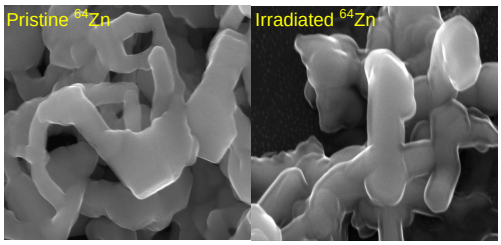


FIG. 3: SEM image of $^{64}$Zn before (left) and after irradiation (right) at 75000 zoom.

## Conclusion

The difficulties in the preparation zinc thin film targets, due to volatility and reactivity of zinc has been addressed. Around 200 $\mu$g/cm$^2$ thick films were produced using resistive heating.

## Acknowledgments

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