Impact of ion beam on thin targets in the heavy element formations

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Heavy ion induced reactions help to understand the super heavy elements formation[1]. Mass distribution measurements of fission fragments coming from these elements give insight of its formation. The precise measurements of the fission fragments play very crucial role in the interpretation of its formations [2]. Straggling loss from bombarding beam and fission fragments inside the target extend the uncertainty in the mass measurements of fission fragments. Hence the accurate knowledge of targets composition and thickness can reduce the uncertainty upto the certain extend.

Keeping in view, our aim was to study the formation of heavy element ^{225}Pa through fission fragments detection. However only a limited number of fabrication method have been reported for enriched thin ^{206}Pb target with thin carbon backing. In present work, fabrication method for ^{206}Pb isotopic thin targets wih carbon backing will be explained. Composition and thickness of ^{206}Pb target has been extracted with help of Rutherford Backscattering Spectrometry (RBS) and Energy Dispersive X-ray fluorescence technique (EDXRF). Raw RBS data were fitted with RUMP software [3]. Mass distribution of fission fragments using ^{206}Pb thin target has been performed.

Annealed ^{12}C deposited slides were clamped with stainless steel stand at a distance of 8 cm from source in a way that material consumption could be minimized. Several attempts were taken with natural material in order to optimize all parameters for reducing enriched ^{206}Pb material consumption. 52 mg enriched ^{206}Pb materials were used to get required thickness and number of target. In each run, chamber was cleaned for avoiding any contamination. The resistive heating method was used for ^{206}Pb material evaporation. Optimized parameters (current 120 Amp, voltage 1 volt and vacuum 1.3×10^{-6} mbar) were employed during whole evaporation. ^{206}Pb thin targets were separated from glass slide in a hot water. Floated ^{206}Pb thin targets were gently taken out from hot water with help of stainless steel target frame with diameter of 10.0 mm [fig 1(C)]. Finally, total 14 ^{206}Pb thin targets were successfully prepared.

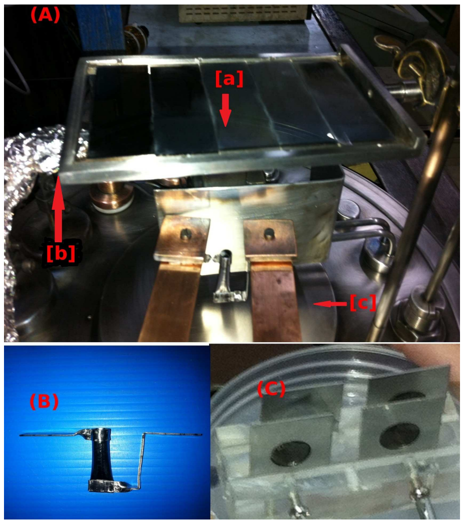

FIG. 1: *Thin targets fabrication set up and its components are (A) [a] Glass substrate, [b] Quartz crystal thickness monitor [c] Resistive heating plate. (B) tube boat made up of tantalum and (C)Thin target in stainless steel target frame*

The thickness of the fabricated targets has been obtained using unitary method. Three x rays peak, Pb-L$_\alpha$ of 10.5 KeV, Pb-L$_\beta$ of 12.5

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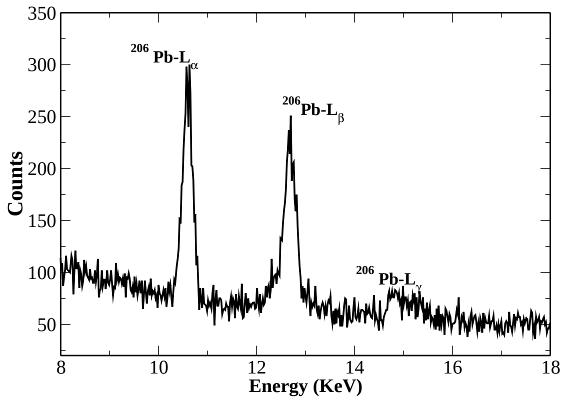

FIG. 2: *Normalized EDXRF specturem of thin target and corresponding three X rays peaks of Pb-L_α, Pb-L_β, Pb-L_γ.*

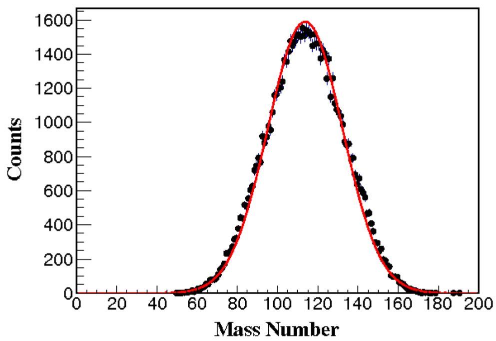

FIG. 3: *Fission fragments mass distribution for ^{19}F+^{206}Pb reaction at 112 MeV laboratory energies. Continuous red line is Guassian fitting of the mass distribution.*

KeV and Pb-L_γ of 14.5 KeV have been observed (Fig 2). From EDXRF measurement, the thickness of target is estimated around the 116 ±5 μg/cm^2.

^{206}Pb thin targets were used in the study of heavy element ^{225}Pa formation through the mass Distribution measurement. Pulsed beam of ^{19}F of 112 MeV was used to bombard the ^{206}Pb target. Width of ^{19}F pulsed beam was 1 ns with the separation of 250 ns. keeping in view the straggling loss of the FFs and ^{19}F pulsed beam [4] inside the target, mass distribution of fission fragments has been extracted from the position signal of MWPCs. Gaussian fitting of the mass distribution has been performed (Fig 3). The mass variance (full width half maximum) of the fission fragments from fitting is 14.8±0.1. Hence we can say that thin targets around 100 μg/cm^2 thickness has very little impact on mass width of fission fragments.

References

[1] Oganessian, Nature 400 (1999) 242245.
[2] R. Vandenbosch et. al., Academic Press, New York (1973).
[3] L. R. Doolittleet. al.,Nuclear Instruments and Methods B 9 (1985) 344-351.
[4] http://www.srim.org/SRIM/SRIMLEGL.html.