Evaporation Residue cross section measurements for Thorium compound nuclei

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Introduction

Synthesis of new massive elements at the end of the periodic table has been a long term goal of nuclear physics research. In order to synthesize super heavy elements (SHE), two heavy nuclei have to be combined either by hot fusion reaction involving actinide targets or by cold fusion reaction with lead and bismuth targets. Reaction and decay dynamics plays a crucial role in the synthesis of SHEs and understanding the latter process will provide inputs in the production of heavier nuclei. The Comprehensive grasp of compound nucleus (CN) formation and decay mechanism is required to reach the nuclear island of stability predicted by theoreticians. In the mass region i.e., $200 < A < 230$ with $80 < Z < 90$ both evaporation and fission decay modes compete with each other. To illuminate the decay mechanism, detailed systematic measurement of evaporation residue (ER) cross section excitation functions is very much required in this mass region, as this is one of the sensitive probes.

Measurement of ER cross sections for O+Pb systems is of special interest as both nuclei having the simple spherical structure with neutron and proton shell closures. So, it would be interesting to study the effect of these shell closure on CN formation and its decay. In an earlier study Keller et al [1], studied the decay of 214Th* produced in two different reactions with different entrance channel mass asymmetry. Neutron-deficient CN 220Th* [2, 3] was produced in three reactions with different mass asymmetry were measured by different groups. In another study 224Th* was produced by three different groups [4–6]. In the present work, we have performed systematic measurements of ER excitation functions for the four reactions ^{16}O+^{204,206}Pb, ^{18}O+^{204,208}Pb systems forming ^{220,222,226}Th* CN at laboratory energies in the range of 85-150 MeV.

Experimental Details

Experimental measurements were carried out at Inter-University Accelerator Centre (IUAC), New Delhi using ^{16}O and ^{18}O ion beams provided by the combined accelerators 15UD Pelletron [7] and LINAC booster [8] facility. Pulsed beams of ^{16,18}O with a pulse repetition rate of 2μs and 4μs are used to probe isotopically enriched ^{204,206,208}Pb targets of thickness 250μg/cm2 with the backing of 30μg/cm2 carbon layer were prepared using vacuum evaporation method at IUAC target laboratory facilities. ER nuclei produced in the thin target recoil out in the beam direction

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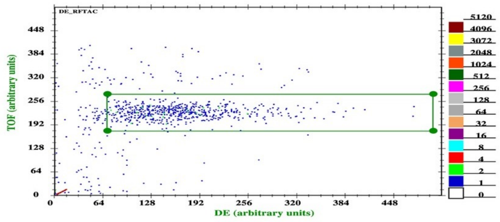

FIG. 1: TOF spectra of ^{16}O+^{206}Pb at 85 MeV

with a very small energy. Magnetic separator, namely Hybrid Recoil Analyzer (HYRA) [9] is operated in gas filled mode to separate ER nuclei from the intense flux of un interacted beam component and elastically scattered particles around zero-degree and transported through the gas medium in presence of a strong magnetic field which are finally detected by the focal plane detector system. Two silicon monitor detectors are placed inside the target chamber at an angle $\pm 26^0$ on either side to detect elastically scattered particles which are used for normalization of beam flux variations. The focal plane detector is a two-dimensional position sensitive multi-wire proportional counter (MWPC) with an active area 6"x2". ER nuclei are identified from the residual background with help of an energy signal from the focal plane detector and the time of flight (TOF) measured relative to the beam pulses. A Typical TOF spectrum generated between delayed anode signal of MWPC and the RF signal from the LINAC is plotted as a function of the energy signal from MWPC as shown in Fig. 1.

Discussion

Fusion evaporation excitation functions for ^{220,222,226}Th* were obtained from the analysis of the experiments are presented in Fig. 2. The survival probability of the CN is expected to be enhanced where shell closures are present and these shell closures are expected to provide extra stability to the CN against fission mode of decay, which will result in increased probability for evaporation process compared to fission decay. Measured excitation functions would be compared with

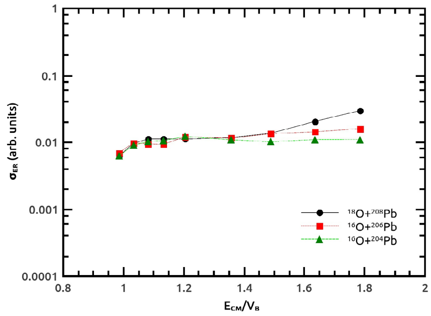

FIG. 2: ER excitation function for ^{16,18}O + ^{204,206,208}Pb reaction

the statistical model calculations. Preliminary analysis has been done, conclusions and results will be presented.

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