Fusion evaporation cross section measurements for $^{16}O+^{204}Pb$ at above barrier energies.

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Introduction

Fusion evaporation reactions leading to heavy compound nuclei with mass beyond A>210 are interesting, due to the onset of fission as competing mode of decay with particle evaporation. Fission gradually becomes dominent with the increasing mass of the compound nucleus(CN). Fusion evaporation process is the only pathway for production of heavier nuclei, but the repulsive Coulomb force between protons will act against the stability of such nuclei by lowering the effective fission barrier. Ultimately, the fission barrier was expected to vanish for nuclei with Z>100 and A>250. Production and study of nuclei beyond was possible only due to presence of shell stabilising effects. Fusion evaporation cross section measurement become difficult for CN that fall in and beyond actinide region, due to the dwindling magnitude of their cross sections.

In the present study, we have taken up a systematic measurement of evaporation cross sections for O+Pb reactions leading to Thorium CN with $220 \leq A \leq 226$. In spite of very small cross sections, availability of the HYRA spectrometer and suitable beam energies from the Pelletron-LINAC Booster facility at Inter University Acccelerator Centre, New Delhi made possible to perform the experiment. Earlier, neutron deficient Thorium CN $^{220}Th^{*}$ formed in the reaction $^{16}O +^{204} Pb$ was studied by measurement of fission cross section [1] and evaporation residue cross-sections [2] (limited to 50 MeV excitation energy). In this present work, fusion evaporation cross-section excitation function is measured for the reaction $^{16}O +^{204} Pb$ upto higher excitation energies.

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Experimental details

Fusion evaporation cross section measurements was carried out for ^{16}O + ^{204}Pb reaction at the Inter University Accelerator Centre (IUAC), NewDelhi using the ^{16}O ion beam with a pulse separation of 2μs and 4μs provided by the Pelletron-LINAC Booster accelerator facility at laboratory energies ranging 85-150 MeV. Isotopically enriched ^{204}Pb targets of thickness 250 μg/cm2 sandwiched between Carbon layers of 30 μg/cm2 backing and 10 μg/cm2 capping. Hybrid Recoil Mass Analyzer(HYRA) in gas filled mode [3] is used to separate the evaporation residue(ER) nuclei from intense background of uninteracted beam component and elastic scattered particles around zero-degree. Experimental details

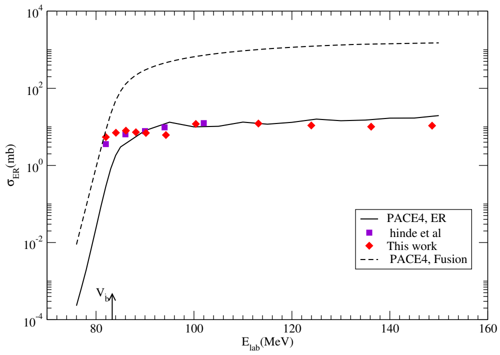

FIG. 1: Measured fusion evaporation cross sections for the reaction ^{16}O + ^{204}Pb plotted along with the statistical model calculations using PACE4 code.

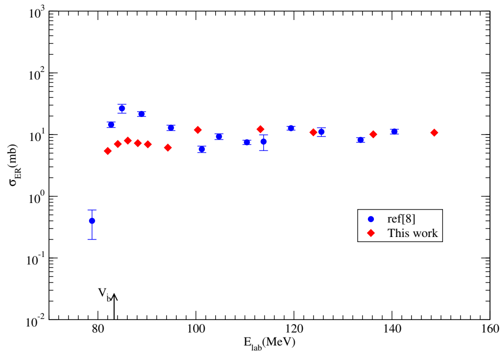

FIG. 2: Experimental ER cross sections for the reaction ^{16}O + ^{204}Pb and ^{16}O + ^{208}Pb

can be found in the reference [4].

Data analysis and results

Yields of the fusion evaporation products are obtained after proper background subtraction from the two-dimesional projection spectrum between energy loss ΔE in the MWPC detector and the Time of Flight (TOF) is measured between the MWPC anode timing signal and the delayed RF signal from the LINAC. To obtain the total evaporation cross-section, HYRA transmission efficiency is needed. The efficiency of HyRA wholly rely on the angular acceptance of HYRA (9.6^0). ER angular distributions were obtained from the PACE4 [5, 6] calculations, using default parameters. Estimated efficiency reduces as α-channels are most prominent, leads to wider angular distribution of ERs. Efficiencies for the present system at each energy was scaled from the calibration reaction by comparing the fraction of their respective angular distributions passing through the HYRA geometrical acceptance. Transmission efficiency of HYRA was estimated following procedure described in the Reference [7]. Experimental ER cross sections are shown in fig. 1.

Fusion evaporation cross sections from the present measurement are in agreement with the previous measurements at lower energies. They compared with the calculated cross sections of the statistical model code PACE4 [5, 6]. Fusion evaporation cross-sections of $^{16}O+^{204}Pb$ reaction are compared with that of $^{16}O+^{208}Pb$ reaction [8], which has almost same mass asymmetry and both the projectile and target are double magic spherical nuclei.

Acknowledgments

Authors thankfully acknowledge the support received from IUAC, NewDelhi in particularly from Target Lab, Data support Lab, Pelletron and LINAC crew during the experiment. Authors PSD and SKD herewith acknowledge the DST-INSPIRE for the financial assistance through the fellowship.

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