Evaporation residue excitation function measurements for the reaction ^{48}Ti+^{138}Ba

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Introduction

The phenomenon of nuclear fission is nearly as old as the modern nuclear physics. The availability of heavy ion beams have opened up a new era of experimental observations and theoretical studies. The production and study of Super Heavy Elements (SHE) has become an important area in the field of experimental nuclear research in the recent times. It has been observed that the synthesis of heavier and heavier elements using heavy ion induced reactions is severley hindered by fission and fission like process called quasi-fission[1].In the case of quasi-fission, after surmounting the Coulomb barrier, the two participating nuclei reseparate before forming the cmpound nucleus. Quasi-fission is a serious competitor for the formation of a compound nucleus and subsequently the formation of evaporation residue(ER). Since quasi-fission occurs before the target and projectile fuse to form a compound nucleus, it hinders the formation of ER[2] Entrance channel properties such as mass asymmetry and deformation of colliding partners affect the probability of quasi-fission significantly. The excitation functions for the system ^{48}Ti + ^{138}Ba have been measured over the energy from 189.3Mev to 234.4MeV.

It has been suggested that if Z_PZ_T > 1600 (where Z_P is projectile charge and Z_T is the target charge.), then it leads to quasi-fission[3]. Later on it was found that quasi-fission is possible even if Z_PZ_T ~ 1000[4]. For studying the factors influencing quasi-fission, we have chosen two systems viz; ^{48}Ti + ^{138}Ba (Z_PZ_T > 1000) and ^{32}S + ^{154}Sm (Z_PZ_T < 1000), both are forming same compound nucleus ^{186}Pt. The experimental study of the symmetric system, ^{48}Ti + ^{138}Ba reaction is reported here and the reaction of asymmetric system, ^{32}S + ^{154}Sm ,is reported elsewhere[5].

Experimental Details

The ER excitation function measurement for the reaction was performed at the 15UD Pelletron + LINAC accelerator facility of IUAC, New Delhi. Pulsed beam of ^{48}Ti with 250ns pulse separation was used to bombard the isotopically enriched ^{138}Ba target of thickness ~200μg/cm^2. The barium target is safeguarded from oxidization with carbon backing and capping of thickness 20μg/cm^2 and 10μg/cm^2, respectively. The measurements were performed at laboratory beam energies 189.3, 195.5, 201.7, 208.9, 215.7, 224.0 and 234.4MeV, where correction have been made for the loss in the pressure window

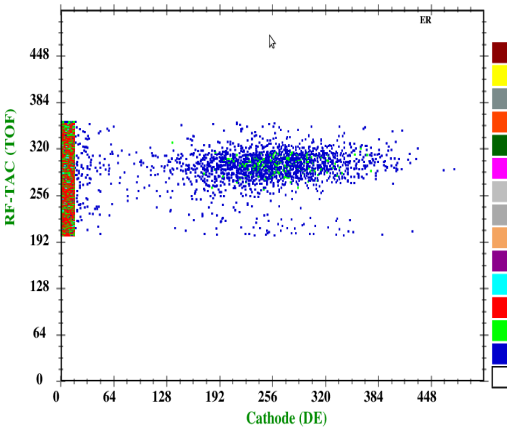

FIG 1: Two dimensional plot of the time of flight versus energy spectrum for ^{48}Ti+^{138}Ba reaction for 251 MeV.

foil, carbon backing and half thickness of the target. A detailed description of target fabrication is given elsewhere [6].

Two silicon detectors were used inside the target chamber, placed at ±25º, to detect the Rutherford scattered beam particles for absolute normalization of ER cross sections. These detectors were also used for positioning the beam at the center of the target.

ERs were separated from the intense beam background using HYbrid Recoil mass Analyzer (HYRA) [7]. The ERs reaching the focal plane were detected using a position sensitive multiwire proportional counter (MWPC) of active area 6 inch x 2 inch. A time of flight (TOF) spectrum was generated with the MWPC anode pulse as start signal and a suitably delayed radio frequency (RF) signal as stop. The energy loss (DE) vs TOF spectrum helps in the unambiguous identification of ERs from the beam-like and the target-like contaminations. As a representative case, a two dimensional plot of DE versus TOF at 241MeV beam energy is shown in FIG 1.

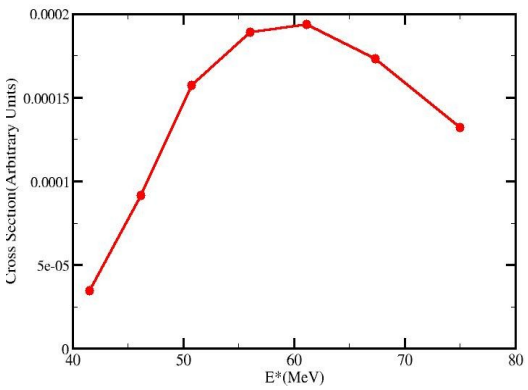

FIG 2: Experimental ER cross section in arbitrary unit for the reaction 48Ti+138Ba.

Results

Experimentally extracted ER cross section in arbitrary units for the system is shown in FIG2. The analysis of the data is in progress.

The total ER cross section can be calculated using the equation,

$$\sigma_{ER} = \frac{Y_{ER}}{Y_{mon}} \left(\frac{d\sigma}{d\Omega} \right) \Omega_M \frac{1}{\xi_{HYRA}}$$

where σ_{ER} is the ER cross section in mb, Y_{ER} is the ER yield at the focal plane, Y_{mon} is the yield in the monitor detector, ϵ_{HYRA} is the HYRA transmission efficiency and Ω_M is the solid angle subtended by the monitor detector. $d\sigma/d\Omega$ is the differential Rutherford scattering cross section in the laboratory system.

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