Experimental study of the production of residues populated via complete fusion and/or incomplete fusion in ^{19}F + ^{181}Ta System

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Introduction

During last couple of decades, the experimental work has been extensively carried out to study the dynamics of heavy-ion (HI) reactions below 10 MeV/nucleons energies [1]. In this energy regime, it has been found that the complete fusion (CF) and incomplete fusion (ICF) processes are dominant reaction mechanisms. In CF process, the projectile completely fuses with the target to form an excited compound nucleus (CN) which may decay by emitting the light nuclear particles. However, in ICF process, the projectile breaks up into fragments (participant and spectator), the participant fuses with the target nucleus to form an incompletely fused excited composite system while the spectator moves on in forward direction with same velocity as that of incident ion.

Earliar measurements showed that only CF process was dominant at energies $<$ 10 MeV/nucleons and the probability of ICF process was found to be negligible [2]. Recent literature suggests that ICF starts competing with CF in the range of 4 to 7 MeV/nucleons, where CF is expected to be the sole contributor [3]. It may be remarked that there is no theoretical models available for studying the ICF reaction dynamics completely. In order to develop some theoretical models on ICF studies, more and more experimental measurements are needed to be carried out. There are various experimental methods by which one can study CF and ICF reactions. One of them is by the measurements and analysis of excitation functions (EFs) of the residues populated in the projectile-target interactions. In the present work, EFs of several residues populated via xn, pxn, αxn and 2αxn in ^{19}F + ^{181}Ta system at energies $\approx$ 4-7 MeV/A have been measured.

Experimental Details

The experiments have been carried out at Inter University Accelerator Center (IUAC), New Delhi by using 15UD pelletron facility. The beam of $^{19}F^{+9}$ has been used for irradiation of ^{181}Ta target (thickness $\approx$ 2 mg/cm^2). The target-catcher foil activation technique has been used to measure the EFs. The targets and catcher foils have been made by rolling technique. The thicknesses of tar-

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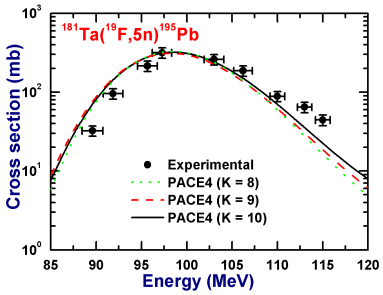

FIG. 1: The experimentally measured and theoretically (PACE4 with K = 8, 9 and 10) calculated excitation functions of ^{195}Pb residues populated in 5n-channel.

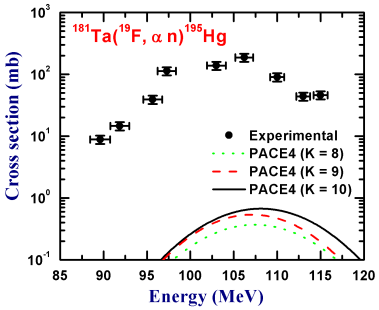

FIG. 2: The experimentally measured and theoretically (PACE4 with K = 8, 9 and 10) calculated excitation functions of ^{195}Hg residues populated in αn-channel.

get and catcher foils were measured by α-transmission technique. Three seperate stacks each having four samples and equal number of catcher foils were irradiated by $^{19}F^{+9}$ beam at energies $\approx$ 110, 115 and 120 MeV, respectively. The irradiations have been carried out in General Purpose Scattering Chamber (GPSC) having In-Vacuum Transfer Facility (ITF). By using ITF facility, the short-lived activities induced in the target-catcher foils assembly has been measured. The activities induced in the target-catcher foils assembly were recorded by a High Purity Germinium (HPGe) detector coupled with a PC having CANDLE software [4]. The resolution of HPGe detector was $\approx$ 2 kev for 1333 keV γ-ray of ^{60}Co. The reaction residues were identified by their characteristic γ-rays and confirmed by decay curve analysis. The intensities of characteristic γ-rays of the reaction residues have been used to determine their cross-section, employing standard formulations [5].

Theoretical calculations of measured EFs have been also performed with the statistical model code PACE4 [6]. The experimentally measured and theoretically calculated EFs for reactions ^{181}Ta(^{19}F, 5n)^{195}Pb and ^{181}Ta(^{19}F, αn)^{195}Hg have been shown in Fig.1 and Fig.2, respectively. As can be seen from Fig.1, the experimentally measured EFs are well reproduced by PACE4 calculations for reaction ^{181}Ta(^{19}F, 5n)^{195}Pb however, for reactions ^{181}Ta(^{19}F, αn)^{195}Hg (Fig.2), enhancement has been found over PACE4 calculations which may be attributed due to significant contributions of the incomplete fusion of ^{19}F projectile with ^{181}Ta target. Further details of the measurements and analysis will be presented.

Acknowledgments

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