Study of complete fusion in $^{18}O+^{89}Y$ at Pelletron energies.

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Introduction

In recent years, study of heavy ion nuclear reactions (HI) is one of the most dominant fields among theoretical as well as experimental nuclear physicists. Presently, reactions induced by heavy projectiles at energies above barrier are quite well explored [1]. These possible reactions can be explained on the account of transfer of linear momentum across projectile-target system.

When the fast-moving incident particle fuses completely with the stationary target to form single entity known as compound nucleus (CN). This process is coined as Complete Fusion (CF). On the basis of the behavior of transfer of linear momentum CF is further classified as: Direct Complete Fusion (DCF), when incident particle fuses entirely with target and complete transfer of linear momentum occurred in a single go. If incident particle breakup in to small fragments and these fragments fuses one by one with the target nucleus. This is termed as Sequential Complete Fusion (SCF). Although comprehensively in both processes, linear momentum transfers completely to the target nucleus. Thus, CF is the algebraic sum of DCF and SCF [2]. In the present work attempt has been made to measure the excitation functions of various residues populated solely through CF in the interaction of + ^{89}Y system and analyze them with the statistical model code predictions.

Experimental Details

The experiment was performed at the Inter-University Accelerator Center (IUAC), New Delhi by utilizing 15UD Pelletron acceleartor facility. Accustomed stacked-foil activation method with offline identification of the reaction residues by their characteristic gamma rays was employed for the present measurements.

The targets of natural ^{89}Y and Al catcher foils were prepared using rolling technique at Target laboratory IUAC, New Delhi. Thickness of foils was estimated by graphical method and further verified using alpha transmission method. The stack formed by ^{89}Y foils followed by thin Al foils was irradiated in General-Purpose Scattering Chamber (GPSC) installed at the 45^{o} beam line in Beam Hall I of IUAC, New Delhi. The beam ($^{18}O^{+8}$) energy was 105 MeV. Al foils serve as energy degrader and catcher foils to trap and stop the recoil residues from the preceding target foil. The irradiation was kept enough so that activity for the residues of interest could produced in the target foils.

Identification of residues and analysis

After irradiation the activities induced in the target foils were followed offline using pre-calibrated HPGe detector which is integrated with computer-automated measurement and control (CAMAC) based data acquisition system. Standard sources ^{22}Na, ^{57}Co, ^{133}Ba and ^{152}Eu of known strength were used to calibrate the energy and efficiency of the HPGe detector.

The spectroscopic data used for the identification of the observed ERs populated through different reaction channels are presented in Table 1 and are adopted from Table of Radioactive Isotopes [4]. Each residual isotope is identified by their characteristic gamma rays and

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Table 1: Spectroscopic details of observed ERs in the interaction of $^{18}O + ^{89}Y$.

Nuclides (Channel)	J^{π}	Half-life	E_{γ} (kev)	I_{γ}, %
^{103}Ag(4n)	$(7/2)^{+}$	65.7 m	118.64	22.0
			148.87	20.0
			243.87	8.5
			531.81	8.75
^{102}Ag(5n)	$(5)^{+}$	12.9 m	556.61	97.7
			719.53	58.0
			1256.9	12.7
^{101}Ag(6n)	$(9/2)^{+}$	11.1 m	261.05	52.6
			274.70	1.68
^{101}Pd(p5n)	$(5/2)^{+}$	8.47 h	269.0	6.43
			296.38	19.2
			565.99	3.44
			723.91	2.05
			1289.0	2.28

are verified by their respective half-live decay curve.

As a representative case, the decay curves of ERs ^{103}Ag and ^{102}Ag respectively, are shown in Fig. 1.(a) and (b)

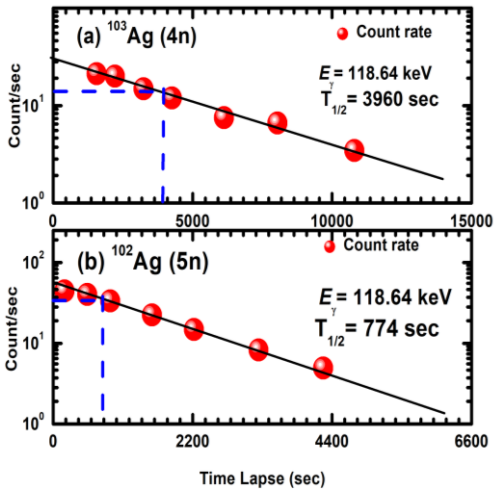

Fig.1 Experimentally measured decay curves of ^{103}Ag and ^{102}Ag by 4n and 5n channels respectively in the interaction of $^{18}O+^{89}Y$ system

The cross sections for identified reaction residues have been calculated using the standard formulation [4]. The measured cross sections are compared to the statistical model code PACE4 [5]. The code PACE4 is built on the statistical approach which deals in the deexcitation of CN followed by Monte Carlo simulation and approximation.

Results and Discussion

The EFs of the ERs populated through CF reactions for $^{18}O + ^{89}Y$ are measured. The EFs for xn and pxn channels are found to be in good accordance with PACE4 predictions. As a reference the EFs for ^{103}Ag are shown in Fig 2. It can be seen that measured cross-sections are in good agreement with PACE4 for K=12. This fully validates that the residues ^{103}Ag, ^{102}Ag, ^{101}Ag and ^{101}Pd are populated exclusively through complete fusion reaction mechanism.

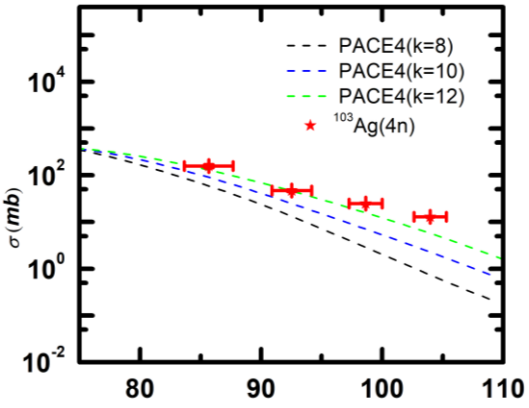

Fig.2 Experimentally measured EFs for ^{103}Ag populated through 4n channel in the interaction of $^{16}O + ^{89}Y$ projectile target system

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