The measurement of evaporation residue cross sections in $^{16}O+^{175}Lu$ system

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Introduction

Formation of heavy and super-heavy residues in heavy-ion induced reactions depends on several factors in the entrance channel (charge product, deformation, magicity etc.) as well as the exit channel (difference between fission barrier and particle separation energy, level density, dissipation etc.). Recent attempts to detect elements beyond Z=118 remained unsuccessful. Understanding the compound nucleus formation and fission survival process in heavy-ion reactions is crucial for accurate prediction of super-heavy element formation. Analysis of the experimental fission fragment mass distributions for $^{16}O+^{175}Lu$, $^{37}Cl+^{154}Sm$ and $^{35}Cl+^{144,154}Sm$ along with other reactions has revealed the significant presence of (slow) quasi-fission for reactions involving projectile with $Z \geq 17$ in the sub-lead region [1]. Quasi-fission occurs when the target-pojectile composite system reseparates before complete equilibration in mass and shape degrees of freedom, keeping the memory of the entrance channel. The evaporation residue (ER) cross-sections can be also used to study the presence of quasi-fission [2, 3]. Further, the measurement of ER cross-sections can help in understanding the statistical competition in compound nucleus decay. With this motivation, we have started a program to investigate the ER cross-sections in the above-mentioned systems in our lab. In this contribution, we are presenting the ER cross-sections measured in $^{16}O+^{175}Lu$ system.

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Experimental Details

The experiment was carried out at BARC-TIFR Pelletron-LINAC Facility, Mumbai. Self-supporting, rolled, natural foils of ^{175}Lu, with thickness 1.2-1.4 mg/cm^2 were irradiated with beam of ^{16}O, in the energy range E_{beam} = 75-95 MeV. Targets were irradiated for approximately 7-8 hrs. for each energy with a typical beam current of 4-50 nA. The beam current was recorded at regular intervals of 1 min. using CAMAC scaler. The γ-rays from irradiated samples were counted offline using two efficiency-calibrated HPGe detectors. The irradiated target foils were mounted at a distance of 10 cm from the face of the detector. Both the HPGe detectors were shielded with Cu-Cd-Pb shielding to reduce the background radiation. The efficiency and energy calibration of the HPGe detectors were done using standard ^{152}Eu and ^{133}Ba γ-ray sources. The compound nucleus ^{191}Au produced in the reaction decays to $^{186-188}Au$ by evaporating successive neutrons (5n-3n), over the energy range of measurement.

Data Analysis

A typical γ spectrum from evaporation residues (ER) detected in the HPGe detector at a beam energy of E_{beam}=82 MeV is shown in Fig. 1. The evaporation residues were identified by their characteristic γ-rays and are marked here. The identification of γ-rays was

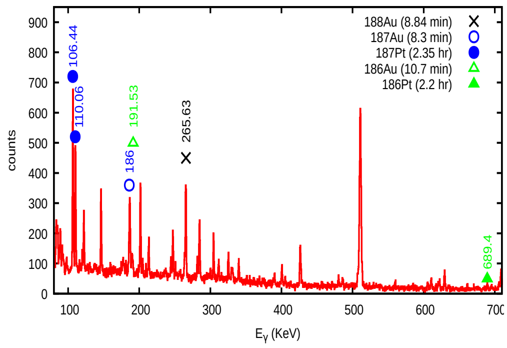

FIG. 1: A typical gamma spectrum from ER detected in HPGE detector at E_{beam} = 82 MeV. The half-lives of each residue are mentioned in the brackets.

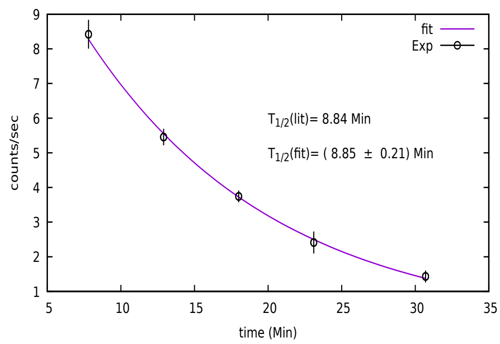

FIG. 2: Activity of the ^{188}Au (E_γ=265.63 keV) evaporation residue as a function of time at E_{beam}=82 MeV. Line corresponds to activity obtained by fitting the data

confirmed by half-life determination as shown in Fig. 2. In the present system the ^{188}Au, ^{187}Au, ^{187}Pt, ^{186}Au, ^{186}Pt residues are dominant. The Beam energies are corrected for the energy loss of the projectile inside the target using the SRIM calculations.

Results and Discussion

The cross sections of the residues were determined from the standard expression used in the offline γ-ray counting [4] considering the yield, half-life, cooling, counting time, efficiency of detector and branching ratio etc. The measured evaporation (x_n) cross-section normalised with total (x_n) cross-sections is

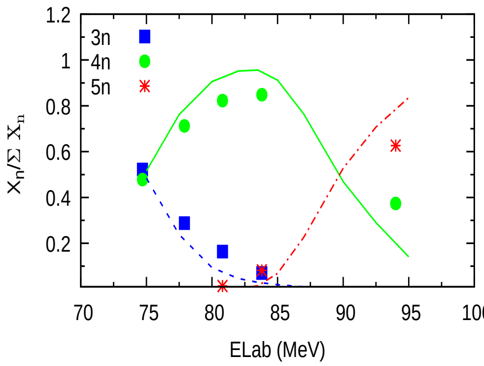

FIG. 3: : The ratios of individual ER cross-section to the total ER cross-section at various energies are plotted. The dashed, solid, and dot-dashed lines represent the ratios estimated in PACE4 calculations for 3n, 4n, 5n channels respectively.

shown in Fig. 3. The cross-section estimated using statistical model PACE4 [5] are also shown for comparison. Further analysis is in progress. The detailed results and comparison with the systematics will be discussed at the conference.

Acknowledgement

We acknowledge the help received from Mr. P. Patale and Mr. A. Kumar during the experiment.

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