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Evaporation residue cross-section measurements for ^{16}O + ^{203,205}Tl

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Evaporation residue cross sections for the ^{16}O + ^{203,205}Tl reactions were measured at laboratory beam energies in the range of 82–113 MeV using a gas-filled separator. Transmission efficiency of the separator was estimated using a calibration reaction ^{16}O + ^{197}Au and by simulating the evaporation residues angular distributions. Statistical model calculations were performed for both the measured systems. These calculations overestimate the experimental evaporation residue cross sections. This could be attributed to the presence of noncompound nuclear fission. An estimation of noncompound nuclear fission contribution was carried out. Comparison with neighboring systems shows that a slight change in the entrance channel or the compound nucleus properties makes a large difference in evaporation residue cross sections.

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I. INTRODUCTION

Heavy-ion fusion-fission reaction dynamics has been an active field of study for the past several decades and it is still not fully understood, especially for the heavier nuclei ($A \geqslant 200$ amu) around the barrier. Heavy-ion fusion reactions are particularly important as they are the most successful mechanisms for superheavy element (SHE) production [1–3].

One-dimensional barrier penetration model explains the nuclear fusion quite reasonably. However, it underestimates the fusion cross sections near and below the Coulomb barrier. The enhancement of experimental reaction cross section was found to be due to the coupling of various internal degrees of freedom, such as static deformation of the collision partners, collective surface vibrations, and transfer channels, etc., with the relative motion [4,5]. The tunneling through the barrier and subsequent capture are enhanced by the coupling of these internal degrees of freedom around the barrier.

As per the compound nucleus (CN) hypothesis, the dinuclear system follows a long dynamical path during which it equilibrates in all degrees of freedom or reseparates into fission-like fragments. The CN which de-excites via particle evaporation or γ emission and survives fission, ends up as various evaporation residues (ER). Formation of these ERs depends on the capture probability, CN formation probability, and its survival probability against fission. The ER cross section is given as

$$\sigma_{\mathrm{ER}} = \sigma_{\mathrm{cap}} \times P_{\mathrm{CN}} \times P_{\mathrm{surv}}, \qquad (1)$$

where σ_{cap} is capture cross section, P_{CN} is CN formation probability, and P_{surv} is its survival probability against fission. For light and very asymmetric systems, merely overcoming the capture barrier is sufficient for CN formation but this is not the case for heavier systems, as they may reseparate before CN formation.

It was observed that at higher excitation energies, the prescission neutron, charge particle, and giant dipole resonance (GDR) γ-decay multiplicities exceed the statistical model predictions [6]. Inclusion of dissipation or viscosity effects into the Bohr-Wheeler formalism [7] is required to explain these higher multiplicities. These effects reduce the fission and increase the particle and γ emission in the presaddle region and thereby the ER cross section. However, often the ER cross sections cannot be reproduced with the same strength of dissipation [8,9]. Usually a smaller dissipation strength is required to reproduce the ER data in comparison with that required for prescission multiplicity data. For a number of systems, the fission is enhanced by reducing the height of the liquid drop model (LDM) fission barrier to fit the ER cross sections [10,11].

While explaining the reaction excitation function, any deviation from the standard statistical model predictions is

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