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Probing role of deformed target on the mass-energy distributions of ^{224}Th at above Coulomb barrier

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One of the key ingredients for the synthesis of Super Heavy Elements (SHE) is the target-projectile combination of the reaction. The role of deformed target on the various Compound and non-Compound reaction mechanisms is yet to be explored [1,2]. The synthesis of SHE is further hindered by the Quasifission mechanism that competes with the formation of a Compound nucleus. The investigation of mass-energy distributions of heavy nuclei allows a detailed understanding of the associated various reaction mechanisms, and therefore is highly desirable to study the Quasifission process [3]. Furthermore, the region of neutron-deficient Th nuclei has not been extensively studied for the multimodal fission phenomenon, which further builds on the primary motivation of the present study [4].

The experiment was performed at the Flerov Laboratory of Nuclear Reactions (FLNR), JINR, Russia, using an energetic ^{48}Ca beam delivered from the $U400$ cyclotron. A thin target of ^{176}Yb with thickness of about 214 μg/cm^2 on 1.5 μm thick Titanium backing was bombarded with the ^{48}Ca beam at six different energies in the range of E_{beam} = 188 to 272 MeV. The measurement of the reaction binary products was carried out by utilizing the double-arm time-of-flight (TOF) spectrometer CORSET [5]. Assuming the conservation of mass of the composite system of projectile and target, the double-velocity method was employed to determine the mass and energy of the reaction products.

The present reaction, ^{48}Ca + ^{176}Yb, leads to the formation of the composite system, ^{224}Th above the Coulomb barrier. The Mass-Total Kinetic Energy (M-TKE) distributions of the primary binary fragments from ^{224}Th have been obtained from the present measurement. The measured M-TKE distribution profiles have been deconvoluted with multiple Gaussian functions to extract the yield contributions of the symmetric and asymmetric components from the fission-like fragments. Due to a comparatively high Coulomb factor, Z_1Z_2 = 1400 and a mass asymmetry value of about 0.57, significant suppression of the compound nucleus, ^{224}Th formation because of enhanced contribution from the Quasifission process is expected. The target nucleus, ^{176}Yb being highly prolate deformed in the ground state (β_2 = 0.3) when bombarded with spherical projectile beam particles of doubly magic ^{48}Ca will further allow to investigate the role of deformed target on the reaction mechanism.

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