Study for fusion-fission and quasifission in reactions using ^{238}U target nucleus

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Fragment mass distributions for fission after full momentum transfer were measured in the reactions of ^{30}Si, ^{31}P, ^{34,36}S, ^{40}Ar + ^{238}U at bombarding energies around the Coulomb barrier [1,2]. The experiment was carried out at the JAEA tandem accelerator. An asymmetric fission probability increases at the sub-barrier energy. The phenomenon was interpreted as the enhanced quasifission probability owing to the orientation effects on fusion and/or quasifission. The result is consistent with the conclusion from the evaporation-residue cross sections produced in ^{30}Si + ^{238}U [3] and ^{34}S + ^{238}U [4], in which hindrance in fusion was observed at the sub-barrier energy.

In the reactions using ^{34,36}S, and ^{40}Ar projectiles, quasifission produces fragments near the double-magic nuclei, ^{78}Ni and ^{208}Pb, as observed in the heavier projectile reactions [5]. Compared to these reactions, the mass asymmetries for quasifission in ^{30}Si+ ^{238}U and ^{31}P + ^{238}U were smaller. A model calculation using three dimensional Langevin equation to give the fragment mass distributions was carried out to interpret the data. The model takes into account the orientation effects. It was suggested that the system ^{30}Si + ^{238}U approaches closer to the shape of a compound nucleus before disintegrating as quasifission. At this point, the fission channel leading to ^{78}Ni/^{208}Pb diminishes but a new fission channel with smaller mass asymmetry opens. We also discuss a method to determine the fusion probability for the heavy-element synthesis.

References

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