Fusion cross-section analysis for SHE Z =120

P. Mohanty[1,a)], S. Jaiswal[2], A. Sen Sharma[2], S. Merchant[2],
A.Anupam[1],G.Tripathy[1],K.K Jena[3]and B.B. Sahu[1,b)]
[1]Department of Physics, School of applied science.
[2]School of computer science and engineering,
KIIT, Deemed to be University, Bhubaneswar-751024, Odisha, INDIA
[3]P.G.Department of Physics, Bhadrak Autonomous College, Bhadrak-756100, Odisha,INDIA

Introduction

The expected "island of stability" caused by nuclear shell stimulates the study of super-heavy materials.Synthesis of these SHE is quite challenging in the field of nuclear physics.Heavy ion reactions has been a significantly used to synthesis of these super heavy elements.For these reactions we need specific combinations of projectile and target nuclei.Compound nuclei are formed at large excitation energies in the range of tens of MeV .For large value of excitation energy, the influence of shell effects diminishes.This diminishing effect leads to lower stability and increased likelihood of decay processes. This reduction in shell stabilization results in extremely low production cross sections measured in picobarns or even less, especially for elements with atomic number Z≥110. This turns out to be a major difficulties often face by researcher for synthesis of SHE.It always needs advanced detection methods and a greater number of experimental study for understanding their properties and behaviors.Our predictions are completely based on evaporation residual cross sections(ER) of fusion reactions.It mainly depends on projectile and target combinations.[1-4]

Theory

The total potential energy for heavy ion fusion reaction can be expressed as,

$$V(r) = V_N(r) + V_{coul}(r) + V_{cent}(r) \qquad (1)$$

Where $V_{coul}(r) = Z_a Z_A e^2/r$ and $V_{cent} = j_c(j_c+1)\hbar^2/2\mu r^2$

The parameters $Z_a Z_A$ is charge product of target-projectile combination, j_c represents total angular momentum of compound nucleus and μ is the reduced mass of compound system. Where $V_N(r)$ is the nuclear potential.

[a]1981140@kiit.ac.in
[b]bbsahufpy@kiit.ac.in

To calculate fusion cross section we used the relation,

$$\sigma_{fus}(E_{cm},J_c) = \frac{\pi}{K^2}(2J_c + 1)P_{fus}(E_{cm}, j_c), \qquad (1)$$

Where j_c represents the total angular momentum of the compound system and k the wave number of relative motion between the projectile and target nuclei. P_{fus} is the fusion probability for the compound nucleus. The compound nuclei attend its ground state configuration by emitting neutrons immediate after fusion.

For the calculation of evaporation residue cross section, we use the following relation,

$$\sigma_{ER}(E_{cm}) = \sum_{Jc\geq 0} \sigma_{fus}(E_{cm},J_c)P_{surv}(E^*_c\, j_c), \qquad (2)$$

Where P_{sur} is the survival probability [5-9]

Results and discussions

For the synthesis of SHE Z=120 we use $^{45}Sc+^{252}Es$ system as a projectile-target combination.Our calculated results are shown in the figure.In Fig.1 it is clearly shows that fusion cross section is gradually increases for higher excitation energies E*.Fig.2 represents the variation of survival probability P_{sur} with mass number A. As the mass number A increases the survival probability also increases.Which gives an better informative idea for the synthesis of SHE Z=120.Later we calculated the evaporation residue cross section for the system $^{45}Sc+^{252}Es$ as shown in the Fig.3.We calculated evaporation residue cross section of the system $^{45}Sc+^{252}Es$ for 2n,3n,4n channels.We get maximum evaporation residue cross section for 4n channel at excitation energy of 44 MeV. From all these observations we predicted that the system $^{45}Sc+^{252}Es$ is the favourable projectile-target combination for synthesis of SHE Z=120.

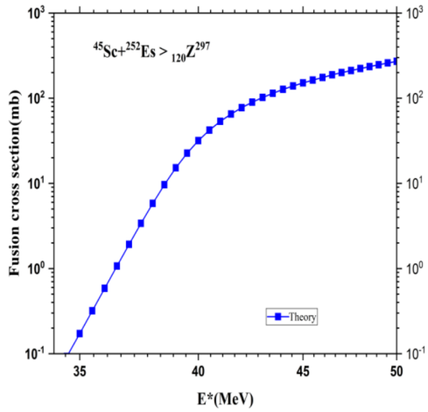

Fig.1 Shows that variation of fusion cross section for the $^{45}Sc+^{252}Es$ system with excitation energy E*

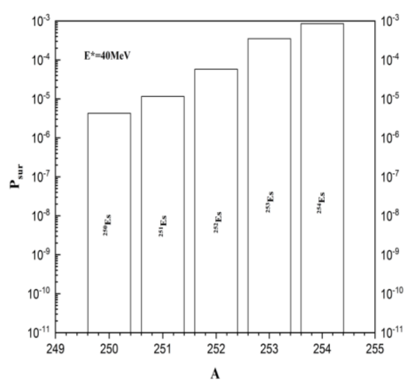

Fig.2 Shows that the variation of survival probability P_{sur} with mass number A

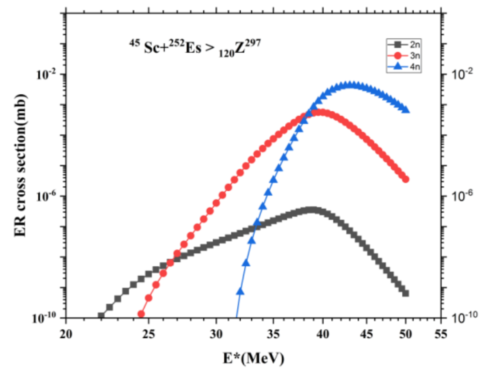

Fig.3 Evaporation residue cross section as function of excitation energy E* for 2n,3n.4n channel

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