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Systematic study of the fusion hindrance phenomenon using the proximity potential approach: signature of the energy-dependent effects of the surface energy coefficient

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Abstract

In the present study, we have systematically studied the role of surface energy coefficient as well as temperature dependence in the fusion hindrance phenomenon of the heavy-ion reactions using the proximity potential formalism. To this end, we have performed the calculations of the interaction potential using the original proximity potential 1977 (Prox. 77) and the fusion cross sections are calculated based on the coupled-channels (CC) approach. The considered fusion systems are including the heavy-ion reactions $^{11}B+^{197}Au$, $^{12}C+^{198}Pt$, $^{16}O+^{208}Pb$, $^{28}Si + ^{64}Ni$, $^{28}Si + ^{94}Mo$, $^{58}Ni+^{58}Ni$, $^{32}S+^{89}Y$, $^{34}S+^{89}Y$, $^{12}C+^{204}Pb$ and $^{36}S + ^{64}Ni$ with conditions of $Q < 0$ and charge product of the participant nuclei $392 \leq Z_1Z_2 \leq 784$. Our preliminary calculations show the Prox. 77 model predicts the theoretical values of the fusion cross-sections less than the corresponding experimental data especially in the energy regions below the fusion barrier. However, the imposing of the mentioned physical effects increases the calculated values of the fusion cross sections and thus improves their agreement with the experimental cross sections for the selected reactions. In addition, by considering the energy dependence on the surface energy constant γ_0 of the proximity formalism at the low energy region we are able to reproduce well the fusion cross sections, the astrophysical factor S(E) as well as the logarithmic derivative L(E) in these regions.

keywords: heavy-ion fusion reactions, fusion hindrance phenomenon, proximity potential, coupled-channels calculations, surface energy coefficient.

For full article, refer to the Persian section