Difference in Evaporation Residue Yields in the Cold and Hot Fusion Reactions

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The synthesis of new superheavy elements was successful in 90th by cold fusion reactions (Z=110-112, Darmstadt, Germany) and in 2000-2010 by hot fusion reactions (*Z*=114-118, Dubna, Russia). It is clear that the survival probability of a heated and rotating compound nucleus decreases by increasing its excitation energy. However, experiments of cold fusion showed a drastic increase of hindrance to complete fusion by increasing the charge and mass of compound nucleus. The fission barrier of the compound nucleus is not a smooth function of the mass number: different isotopes have different fission barrier. In some cases, due to the shell effects, the isotopes with less neutron number has larger fission barrier in comparison with an isotope having larger neutron number. For example, the cross section of the synthesis of superheavy element Hs (*Z*=108) was equal to 65 pb in the ^{58}Fe+^{208}Pb reaction [1]. This result is much larger than 3 pb obtained for this aim in the hot fusion ^{26}Mg+^{248}Cm reaction [2], though fusion cross section of the latter reaction is much larger than that of the former reaction. The advantage of using the cold fusion reaction with ^{208}Pb is connected with the fact that it produces the isotope ^{266}Hs having a larger fission barrier than the one of isotope ^{274}Hs formed in the ^{26}Mg+^{248}Cm reaction at low excitation energy. Therefore, the condition for synthesis of the ^{266}Hs element was more favorable than for the case of ^{274}Hs. In the talk, as well as we will discuss the unexpected large value of 16 pb for the cross section of the isotope ^{270}Hs synthesis in the 4n emission channel of the ^{48}Ca+^{226}Ra reaction [3], whereas, the same isotope was obtained with the cross section of 3 pb in the more mass asymmetric ^{26}Mg+^{248}Cm reaction. The compound nuclei formed in these reactions have the same fission barrier at ℓ=0 but their angular momentum distribution can be different, and, consequently, the effective fission barriers are different for the same Hs isotope formed by the above-mentioned two reactions. We have to analyze the other quantities as excitation energy and partial fusion cross sections for both compared reactions ^{26}Mg+^{248}Cm and ^{48}Ca+^{226}Ra. The hindrance to complete fusion in the ^{48}Ca+^{226}Ra reaction seems to be not so strong. The similar comparison will be presented for the ^{48}Ca+^{248}Cm and ^{58}Fe+^{232}Th reactions leading to formation of the two isotopes of the new superheavy element Lv (Z=116) with *A*=296 and *A*=290, respectively. Preliminary results showed that the fusion excitation function of the ^{48}Ca+^{248}Cm reaction is 10 times larger than that of the ^{58}Fe+^{232}Th reaction. We will compare yields of evaporation residue in the reactions under discussion.

1. S. Hofmann, *et al.*, Z. Phys., A **358** (1997) 377.
2. J. Dvorak, *et al*., Phys. Rev. Lett. **100** (2008) 132503.
3. Yu. Ts. Oganessian, *et al*., Phys. Rev. C. **87** (2013) 034605.