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Study of heavy-ion induced fission for heavy-element synthesis

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Fusion reactions using actinide target nuclei have been extensively used to investigate super-heavy nuclei (SHN). The reasons are (1) a relatively neutron rich SHN compared to the cold fusion reactions are produced, thus the decay properties of these nuclei have information on the structure in the vicinity of the spherically closed-shells at Z=114,120 and N=184, (2) nuclei having a relatively long half-lives allow us to study chemical properties, and (3) the cross sections maintain values of a few pico-barn even at the heaviest elements [1]. Understanding of fusion using actinide nucleus is important to estimate the cross sections to produce more exotic SHN and explore this field.

We are studying fusion reaction involving ^{238}U target nucleus using in-beam fission experiment. In the reactions of ^{30}Si,^{31}P,^{34,36}S,^{40}Ar,^{40,48}Ca + ^{238}U, the fragment mass distributions changed drastically with incident energy [2-5]. The data shows the competition between fusion-fission and qasifission, and the results are interpreted by the effects of nuclear orientation arising from the prolate deformation of ^{238}U. We developed a model to calculate the fission-fragment properties in heavy-ion collision based on a fluctuation dissipation model, where orientation effects are taken into account [6]. The calculation reproduced the mass distributions and their incident energy dependence. Fusion probabilities are determined in this approach, which are consistent with those determined from the evaporation residue cross sections of ^{263,264}Sg [3] and ^{267,268}Hs [4], produced in the reactions of ^{30}Si + ^{238}U and ^{34}S + ^{238}U, respectively. We also suggest that the incident beam energy can be extended to the sub-barrier region for the heavy-element synthesis, allowing us to produce more neutron-rich SHN. Discussion will be also given in the ^{48}Ca + ^{238}U reaction, leading to the copernicium isotopes (Z=112) [7,8].

[1] Yu.Ts. Oganessian, J. Phys. G, **34**, R165 (2007).
[2] K. Nishio *et al*., Phys. Rev. C, **77**, 064607 (2008).
[3] K. Nishio *et al*., Phys. Rev. C, **82**, 044604 (2010).
[4] K. Nishio *et al*, Phys. Rev. C, **82**, 024611 (2010).
[5] K. Nishio *et al*., Phys. Rev. C, **86**, 034608 (2012).
[6] Y. Aritomo *et al*., Phys. Rev. C, **85**, 044614 (2012).
[7] Yu.Ts. Oganessian *et al*., Phys. Rev. C, **70**, 064609 (2004).
[8] S. Hofmann *et al*., Eur. Phys. J. A **32**, 251 (2007).