ACTINIDE SYMMETRIC/ASYMMETRIC NUCLEON-INDUCED FISSION UP TO 200 MeV

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The transition from asymmetric to symmetric (SL) fission in actinide neutron-induced fission is a long-standing problem of nuclear fission. Recently it was investigated experimentally for the ^{235}U(n,f) reaction for $E_n \lesssim$250 MeV, as a function of the excitation energy [1] of fissioning nucleus prior to scission. In the emissive fission domain branching ratio of symmetric and asymmetric ^{238}U neutron-induced fission modes $\sigma_{nf}^{sym}/(\sigma_{nf}^{sym} + \sigma_{nf}^{asym})$ was obtained by Zoller et al. [2] up to E_n ∼500 MeV. Below emissive fission threshold measured SL-mode fission cross sections of ^{235}U(n,f), ^{238}U(n,f) and ^{237}Np(n,f) reactions up to the emissive fission threshold could be described within a Hauser-Feshbach statistical model. A separate rather high outer fission barrier with significant transparency was assumed for the SL-mode, while the inner one was assumed to be the same for the symmetric SL- and the asymmetric (S1+S2)-modes. Axial asymmetry and mass-symmetry is assumed for the outer saddle of the SL-mode, as distinct from the S1- and S2-modes, for which saddles are axially symmetric and mass-asymmetric. With increase of the incident nucleon energy above emissive fission threshold and up to E_n ∼200 MeV about ∼20 nuclides might contribute to the fission observables, however this number is dependent upon the target nuclide fissility, being lower for the higher fissilities. Observed neutron-induced fission cross sections of ^{238}U target nuclide could be described in a fission/evaporation approximation up to E_n ∼200 MeV. To describe the ratio of the symmetric mode fission cross section σ_{nf}^{symm} to all fission events for ^{238}U(n,f) reaction [3] we assume that for $E_n \gtrsim$80 MeV neutron-deficient nuclei contribute mostly to the observed fission cross section. Observed fission cross sections of lower mass uranium target nuclides ^{235}U, ^{233}U are calculated based on the consistent description of branching ratio and observed fission cross section of ^{238}U(n,f) reaction. Observed neutron-induced fission cross sections of ^{232}Th, ^{237}Np and ^{239,240,242,244}Pu targets are described in fission/evaporation approximation up to E_n ∼200 MeV. Sensitivity of branching ratio to the target nuclide fissility is investigated also for the ^{232}Th, ^{237}Np and ^{239,240,242,244}Pu target nuclides. The probability of symmetric fission in ^{235}U(n,f) reaction for $E_n \lesssim$200 MeV [1] is investigated as a function of excitation energy of fissioning nucleus prior to scission, for that the partial (n,xnf) reaction neutron spectra are calculated within a Hauser-Feshbach statistical model. Symmetric/asymmetric mode partitioning of fission cross section is compared for the ^{238}U(n,f) and ^{238}U(p,f) reactions up to $E_{n(p)}$ ∼200 MeV.

References

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