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Experimental studies of the 232Th + 48Ca ⟶ 280Ds and 238U + 40Ar ⟶ 278Ds reactions: New isotopes 268Sg, 272Hs, 276Ds, and 275Ds.

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The 232Th + 48Ca reaction has been studied at the gas-filled separator DGFRS-2 online to the cyclotron DC280 at the SHE Factory at JINR. At three low 48Ca energies, three new even-even nuclides were synthesized for the first time: a spontaneously fissioning (SF) 268Sg with the half-life TSF = 13 s; an alpha-decaying 272Hs with T = 0.16 s and E = 9.63 ± 0.02 MeV; and 276Ds with T1/2 = 0.15 ms, E = 10.75 ± 0.03 MeV, and an SF branch of 57%. The decay properties of these nuclei are in agreement with the systematics of experimental partial half-lives and alpha-decay energies of heavy known nuclei, as well as spontaneous-fission half-lives. The cross sections of the 4n-evaporation channel of 0.07 pb, 0.7 pb, and 0.11 pb were measured at 231, 238, and 251 MeV, respectively. At two higher projectile energies of 251 and 257 MeV, new isotope 275Ds with the half-life of 0.43 ms and alpha-particle energy of 11.20(0.02 MeV was synthesized in the 48Ca-induced reaction with actinide nucleus and identified by measuring correlated alpha decays ending in known nuclei. The 238U + 40Ar reaction was studied at 212 MeV resulting in observation of 273Ds. The decay properties of nuclei originating from 273Ds and 275Ds are compared with theoretical calculations and decay schemes are proposed. The cross sections of the 232Th(48Ca,5n)275Ds reaction of 0.11 pb and 0.34 pb were measured at excitation energies of the 280Ds compound nucleus E= *51 and 56 MeV, respectively. The cross section of the 5n-evaporation channel of the 238U + 40Ar reaction at E* = 49 MeV of 0.18 pb turned out to be comparable to that for 275Ds at close excitation energy.

For the first time since 1983, when the first experiments on the synthesis of Ds isotopes in direct reactions of 40Ar, 48Ca with isotopes of actinide elements (232Th, 235,236,238U) were carried out, the reaction cross section was measured, which turned out to be an order of magnitude smaller than the cross section of the 226Ra(48Ca,4n)270Hs reaction. When moving to heavier elements (Z>110), the cross section increases, reaching a maximum value for elements 114-115, and then decreases by about 30 times for element 118. Such variation is in full agreement with theoretical models predicting shells at Z=108, N=162 and Z=114, N=184.

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