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Observation of 18 new microsecond isomers among fission products from in-flight fission of 345 MeV/nucleon ^{238}U

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In-flight fission with a high-energy ^{238}U beam provides the efficient means to produce neutron-rich nuclei far from stability over a wide range of atomic number roughly ranging from 30 to 60. Taking this unique advantage, we performed a comprehensive search for new isomers [1] as well as new isotopes [2] by the in-flight fission of 345 MeV/nucleon ^{238}U at RIKEN RIBF. Fission fragments were separated and identified using the BigRIPS in-flight separator and were implanted in an aluminum stopper at the focal plane. Delayed γ rays were detected within a time window of 20 μs following the implantation using three clover-type high-purity germanium detectors. We identified a total of 54 isomers with half-lives of ~ 0.1 - 10 μs, including the discovery of 18 new isomers: ^{59m}Ti, ^{90m}As, ^{92m}Se, ^{93m}Se, ^{94m}Br, ^{95m}Br, ^{96m}Br, ^{97m}Rb, ^{108m}Nb, ^{109m}Mo, ^{117m}Ru, ^{119m}Ru, ^{120m}Rh, ^{122m}Rh, ^{121m}Pd, ^{124m}Pd, ^{124m}Ag, and ^{126m}Ag. A wealth of spectroscopic information on observed isomeric decays allowed us to propose 15 new level schemes for the 12 new isomers and 3 known isomers, ^{82m}Ga, ^{92m}Br, and ^{98m}Rb, as well as 2 revised level schemes for the known ones, ^{108m}Zr and ^{125m}Ag. We investigated the nature of nuclear isomerism in relation to the evolution of nuclear structure far from stability, e.g., the evolutions of the N=34 subshell gap and shell structure at N ~ 51, a sudden onset of nuclear deformation at N ~ 60 with shape coexistence, emergence of a variety of nuclear shapes at N ~ 68 with their coexistence. We also found several new isomers, such as ^{117m,119m}Ru and ^{120m,122m}Ru, in the unexplored region at N ~ 75. Shape isomerism was suggested from the hindered transition probabilities for ^{117m,119m}Ru. The ETFSI-Q mass model [3] shows the occurrence of large deformation at this region in the systematic behavior of two neutron separation energies. We proposed that these new isomers are generated by shape coexistence in a new well-deformed region of N ~ 75, similarly to the case of N ~ 60.

[1] D. Kameda, T. Kubo et al., Phys. Rev. C **86**, 054319 (2012).
[2] T. Ohnishi, T. Kubo et al., J. Phys. Soc. Jpn. **79**, 073201 (2010).
[3] J. M. Pearson et al., Phys. Lett. B **387**, 455 (1996).

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