

Production cross sections of ^{175}Hf in the $\text{natLu}(p,xn)$ and $\text{natLu}(d,xn)$ reactions

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A long-lived isotope of Hf, ^{175}Hf ($T_{1/2} = 70$ d), is useful for basic studies for rutherfordium (Rf, $Z = 104$). This isotope is producible in no-carrier-added form in the proton- and deuteron-induced reactions on natLu. However, excitation functions of these nuclear reactions have been scarcely studied. In this work, we measured the excitation functions of the $\text{natLu}(p,xn)^{175}\text{Hf}$ and $\text{natLu}(d,xn)^{175}\text{Hf}$ reactions up to 18-MeV proton and 24-MeV deuteron energies using a stack-foil technique and a γ -ray spectrometry. We performed these experiments at RIKEN and Institute for Nuclear Research (ATOMKI). The target stacks of Ta/Lu/Ti and Lu/Ti foils were irradiated for 2 h with proton or deuteron beams of approximately 180–240 nA. After the irradiation, each foil was subjected to γ -ray spectrometry with Ge detectors. We noticed that the half-life of ^{173}Hf is slightly longer than that adopted in the current nuclear database. Therefore, we measured a precision half-life of ^{173}Hf in a separate experiment. In this work, we could measure the excitation functions of the $\text{natLu}(p,xn)^{173,175}\text{Hf}$ and $\text{natLu}(d,x)^{173,175}\text{Hf}$, $^{173,174m,174g,176m,177m,177g}\text{Lu}$ reactions. Thick-target yields of ^{175}Hf were also deduced from the measured excitation functions. The yields are 0.47 MBq/ $\mu\text{A}\cdot\text{h}$ at 17.2-MeV proton and 2.0 MBq/ $\mu\text{A}\cdot\text{h}$ at 24.0 MeV deuteron. We determined the half-life of ^{173}Hf to be 24.176 ± 0.012 h which is 0.58 ± 0.10 h longer than that in the database.

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