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Nuclear reaction study for high-level radioactive waste: Cross section measurements for proton- and deuteron-induced spallation reactions of long-lived fission products

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The disposal of high-level radioactive waste from nuclear power plants is one of the major issues in worldwide. As a promising solution, research and development has been devoted to the partitioning and transmutation technology where long-lived nuclides are converted to stable or short-lived ones. In particular, the transmutation on the long-lived fission products (LLFPs) has received much attention because the LLFP nuclei have large radiotoxicities and they can be produced continuously in the accelerator driven systems and next-generation nuclear reactors. However, experimental reaction data for LLFP nuclei are very limited.

Aiming at bringing a new invention to the nuclear transmutation on LLFP, we have performed a series of systematic studies on the proton- and deuteron-induced spallation for the long-lived fission products (^{90}Sr,^{93}Zr,^{107}Pd,^{126}Sn,^{137}Cs) at reaction energies ranging from 50 to 200 MeV/nucleon at RIKEN Radioactive Isotope Beam Factory. The inverse kinematics technique was adopted. Namely, LLFP beams were used and proton/deuteron targets were conducted to induce the reactions. Our study on ^{137}Cs and ^{90}Sr [1] is the first attempt in the history of nuclear physics to solve the problem of the LLFP transmutation and has triggered the reaction studies for other long-lived fission products.

The present work focuses on ^{137}Cs, ^{90}Sr and ^{107}Pd. Cross sections on proton/deuteron were successfully obtained for these three nuclei and both target and energy dependence of reactions were investigated. In addition, the newly obtained data were compared with the nuclear interaction model including both intranuclear cascade and evaporation processes in the frame work of the Particle and Heavy Ion Transport code System (PHITS). In the presentation, the results for LLFP nuclei ^{137}Cs, ^{90}Sr [1] and ^{107}Pd [2] as well as the potential of spallation reaction on the LLFP transmutation will be discussed.

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[2] H. Wang, H. Otsu, H. Sakurai et al., Phys. Theor. Exp. Phys. 2017, 021D01 (2017).

Authors: WANG, He; Dr OTSU, Hideaki (RIKEN NIshina Center); SAKURAI, Hiroyoshi (RIKEN); Dr TAKEUCHI, Satoshi (Tokyo Institute of Technology); WATANABE, Yukinobu (Kyushu University); Dr KAWASE, Shoichiro (Kyushu University); Dr SUMIKAMA, Toshiyuki (RIKEN Nishina Center); Dr CHIGA, Nobuyuki (RIKEN Nishina Center)

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