ADVANCED LASER PHOTOIONIZATION TECHNOLOGY FOR SEPARATING THE LONG-LIVED ACTINIDES ISOTOPES

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Using a modern nuclear-energy cycle is connected with several known serious risks and problems. The key first reason is connected with content of the dangerous radio nuclides, which are contented in the working nuclear fuel [1]. One of the possible solutions is using γ-neutron transmutation method or others. To make more effective a transmutation one must take into account that the targets should be made of the nuclear isotopes fractions of ^{90}Sr, ^{137}Cs and the iodine fraction too (the most radio toxical ^{129}I isotope). The important problem here is separation of ^{90}Sr,^{137}Cs,^{129}I isotopes from the stable ^{88}Sr, ^{133}Cs, ^{127}I. The aim of our work is carrying out the optimal laser photoionization technology (LPT) for separating long-lived actinides and nuclear fission products (e.g.Sr,Cs,I). Though the nuclides fractions of Zr, Pd, Sn, Tc and rare-earth ones should not be transmuted as the middle activity nuclear fusion coils, here we find the optimal parameters too. The optimal LPT scheme could be based on laser excitation of isotopes into excited Rydberg states and further autoionization (1st mechanism) [2] or stochastic collisional ionization (2ndone) [3]. To carry out computing optimal parameters for the ^{88}Sr, ^{133}Cs, ^{127}I, ^{93}Zr, ^{99}Tc, ^{107}Pd, ^{126}Sn, ^{151}Sm, $^{238\text{-}242}$ Pu, $^{241\text{-}243}$Am, $^{242\text{-}244}$Cm, Cf, U isotopes separating we used the optimized atomic code, operator perturbation theory, the Focker-Plank stochastic equation method, optimal laser action model and density matrices formalism [2,3]. The optimization LPT procedure is in searching optimal form of laser pulse in order to provide a maximum of excited particles in a separation scheme (one of the possible versions). As example let's consider the laser separation scheme for $^{235\text{-}238}$U isotopes. It includes: i). laser excitation of the ^{235}U isotopes from ground $5f^36d7s^2$-$^5L_6^o$ state and low-lying metastable $5f^36d7s^2$-$^5K_5^o$ state, E=620.32см$^{-1}$; ii). transition to autoionization state with doubly excited shell and then auto-or collision ionization. A scheme for sensing the nuclear reaction products is considered on example of the spontaneous fusion ^{252}Cf isotope on the unsymmetrical coils (Cs). Laser photoionization sensing the Cs isotopes is based on the resonant excitation of Cs (the wavelengths are used: $6^2S_{1/2}$-$7^2P_{3/2}$, 4555Å; $6^2S_{1/2}$-$7^2P_{1/2}$, 4593Å) and further autoionization. The novel moment is in that there are listed the concrete optimal set of energetic and radiative parameters: pulse form, duration, energetic for laser and electric field pulses etc for sensing and separation studied isotopes and reactions products.

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