Ion source development of the on-line isotope separator at JAERI*

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The JAERI on-line isotope separator (JAERI-ISOL) [1] at Japan Atomic Energy Research Institute, Tokai, is utilized to search for new isotopes and to investigate spectroscopic studies for nuclei far from stability. So far, two type of ion sources have been developed – a cavity type thermal ion source and a gas-jet coupled thermal ion source [2]. Both sources can give high ionization efficiencies for lanthanide and actinide atoms. With the previously established ion-source technique using mono-oxide ion formation in the thermal ion source [3], the new isotopes ^{121}La, ^{125,127}Pr were identified in heavy-ion fusion residues [4,5]. Further, with the gas-jet coupled thermal ion source, the new isotopes ^{159}Pm, ^{161}Sm, ^{165}Gd, ^{166,167,168}Tb produced in the proton-induced fission of ^{238}U have been identified [6].

Thereafter, to extend our investigation to the actinide region, the mass-separation of neutron-deficient americium and curium isotopes produced via ^{233,235}U(^{6}Li,*x*n), ^{237}Np(^{6}Li,*x*n) reactions was attempted. For effective transport of actinide atoms from the target chamber to the thermal ion source, we developed a gas-jet coupled multiple-target chamber. This chamber can be set about 20 target foils, thus, the effective target thickness of about 2 mg/cm^2 is achieved. Then, we successfully applied to the identification of the new isotope ^{236}Am produced in the ^{235}U(^{6}Li,5n) reaction [7].

To further the study of more neutron-deficient americium and curium isotopes, ^{233,234,235}Am, ^{237}Cm whose production cross sections are estimated to be 1-10 μb in ^{233,235}U(^{6}Li,*x*n) reactions and 1 μb in ^{237}Np(^{6}Li,6n) reaction, respectively, we needed the improvement of the overall efficiency and the stable operation of the ion source for long time without serious restrictions. The overall efficiency of 0.3-0.4% including ionization efficiency and transport one of the gas-jet system for americium atoms was achieved by using the He/PbI_2 aerosol jet system. A long operation of the whole system was examined in on-line experiment for the mass separation of ^{235}Am produced in the ^{235}U(^{6}Li,6n) reaction. The beam intensity of ^{235}Am was stable during the experiment. This indicates that the ion source can be stably operated for 100 h or more. The performance of the present system was demonstrated in an identification of the new americium isotope ^{233}Am [8].

This contribution describes the performance of the multiple-target He/PbI_2 aerosol jet system coupled with the thermal ion source used for the mass-separation of americium and curium isotopes produced in ^{233,235}U(^{6}Li,*x*n), ^{237}Np(^{6}Li,*x*n) reactions. The identification of the new neutron-deficient ^{233}Am [8] and ^{237}Cm isotopes with this system is also presented. In addition, the future plan using an integrated target-FEBIAD-type ion source and a surface ionization type one designed for mass separation of neutron-rich isotopes produced in the proton-induced fission of ^{238}U will be introduced.

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