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Utilization of fluoride target sample material for ^{239}Pu measurement with MILEA AMS

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Accelerator mass spectrometry (AMS) is a very sensitive analytical method for determination of ultra-trace concentrations of long-lived radionuclides in environmental samples. Plutonium isotopes Pu-239, 240 are anthropogenic alpha emitters with a half-life of 24 and 64 thousand years, a commonly monitored in the environment due to plutonium radiotoxicity. In practice, AMS measurement of Pu-239/240 ratio enables to identify the origin of plutonium emission in the environment, whether it originates from global fallout or releases from nuclear facilities.

The aim of this research was to evaluate the performance of prepared plutonium fluoride matrices with the 300kV MILEA AMS system at ETH Zürich in order to lower the detection limit. The measurements included tuning the system for ^{239}Pu determination using fluoride and oxide target samples, background analyses of both target matrices, focusing on the ^{238}U interference, and ionization efficiency tests for plutonium extracted in the form of PuF_4^- , PuF_5^- and PuO^- . The influence of the different matrices on separation of ^{239}Pu from interfering ^{238}U was investigated by doping selected samples with different amounts of uranium.

Plutonium fluoride matrices based on lanthanide co-precipitation have been tested similarly to uranium fluorides as potential target materials in previous studies. Compared to commonly used oxides, these materials of plutonium can possibly suppress isobaric interferences and provide significantly more intense beams and higher ionization yield values over shorter sputtering periods. Analysed samples were prepared by co-precipitation of plutonium from hydrochloric or nitric acid solutions by adding praseodymium chloride carrier and hydrofluoric acid. After washing and drying the material was mixed with lead fluoride to increase the extracted ion currents. Plutonium oxide incorporated into iron oxide carrier mixed with niobium powder was used as a reference material. In both cases, the chemical analysis confirmed successful incorporation of plutonium into PrF_3 and Fe_2O_3 , respectively, with co-precipitation yields over 99%.

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