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Determination of trace amounts of plutonium isotopes in environmental samples containing uranium and plutonium particles by using ICP MS

Laboratories of IAEA Network use thermo ionization mass spectrometry (TIMS) for determination isotopic composition of trace amounts of plutonium in environmental samples. But in case of analysis of a lot of samples, the most productive method should be used, such as an inductively coupled plasma mass spectrometry (ICP MS).

ICP MS has significant obstacle for correct measurement of plutonium isotopic composition –presence of uranium in the samples. Hydride ions $^{238}\text{UH}^+$ contribute to the ion current in the mass range 239. Moreover some of ions of ^{238}U contribute to the ion currents in the mass range 239-242 amu due to “tails” of peaks in the mass spectrum. Relative amount of such ions in all ^{238}U ions are from 10^{-8} to 10^{-4} , and they increase detection limits of plutonium isotopes and deteriorate accuracy of measurements.

An approach is proposed to decreasing of the uranium amount in preparations. First ploy is finding the fragments with largest amount of plutonium by the alpha-autoradiography. Second expedient is the chromatographic separation of uranium and plutonium with column filled with anion exchange resin. It allows to reach the purification of the dissolved fragments from uranium at the level of 5×10^4 , while the loss of plutonium is no more than 40%.

All measurements were carried out using the Thermo Element 2 mass spectrometer. Model preparations with uranium content ranging from 1×10^{-5} μg to 1mg were used (such as uranium content in real samples). The relative content of plutonium and uranium in all model preparations varies in range ($\text{CPu}/\text{CU} = 0.001 \dots 1000$). The detection limit for all plutonium isotopes in the absence of a significant amount of uranium in the sample is about 0.01pg. Analysis of model preparations with a content of uranium about 1mg (as the most unfavorable case) determine following detection limits for plutonium isotopes: ^{239}Pu –2.52pg, ^{240}Pu –0.15pg, ^{241}Pu –0.06pg, ^{242}Pu –0.03pg. The minimum content of plutonium, sufficient to measure the ratios $^{240}\text{Pu}/^{239}\text{Pu}$, $^{241}\text{Pu}/^{239}\text{Pu}$ and $^{242}\text{Pu}/^{239}\text{Pu}$ is in the range from 5pg to 15pg (depending on the plutonium isotopic composition).

Which “Key Question” does your Abstract address?

TEC1.1

Topics

TEC1

Author: Mr ZHIZHIN, Kirill (Laboratory for Microparticle Analysis)

Co-authors: Mr KUCHKIN, Alexander (Laboratory for Microparticle Analysis); Dr STEBELKOV, Vladimir (Laboratory for Microparticle Analysis)

Presenter: Mr ZHIZHIN, Kirill (Laboratory for Microparticle Analysis)

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