Spent nuclear fuel analysis by resonance ionization mass spectrometry

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Nuclear fuel begins as fairly pure uranium oxide or metal, but accumulates fission and neutron capture products as it self-irradiates in a reactor. The isotopic compositions of those products, as well as the altered composition of the uranium itself, provides valuable information on reactor operation history for comparison with declared activity. Because spent fuel is extremely radioactive, methods that maximize information return from small samples (i.e. particulates) with as little handling as possible are valuable.

Resonance Ionization Mass Spectrometry (RIMS) is a powerful *in situ* method of isotopic analysis for a variety of materials because it operates directly on solids and can discriminate against isobaric elements without chemical purification. We present advanced RIMS techniques for nonproliferation and forensic applications. Several new U, Pu and Am methods solve problems in spent fuel actinide analysis, such as the resolution of the isobaric pairs ^{238}U / ^{238}Pu and ^{241}Pu / ^{241}Am. We also present new methods for the analysis of fission products such as ^{88,90}Sr, ^{85,87}Rb, ^{96,97,98,100}Mo and ^{137,138}Ba. Many of these elements are analyzed simultaneously, thereby reducing the amount of material required to characterize a sample. We also present a hydbrid method that combines RIMS with Secondary Ion Mass Spectrometry (SIMS) of fission product Cs (^{133,135,137}Cs) to extract further information without extra sample consumption.

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