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Preparation of dried sources in 4 pi absorbers for total decay energy spectrometry using nanoporous gold

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Total decay energy spectrometry (Q spectrometry) with cryogenic detectors is a promising technique for analysis α-emitting actinides. The radioactive sample is embedded in a 4 pi absorber, and the total decay energy (Q value) for each disintegration is measured. The energy spectrum is therefore simple: there is one peak per radionuclide corresponding to the Q value. The high energy resolution of cryogenic detectors is sufficient to distinguish the peaks at the different Q values. However, this technique is very sensitive to the self-absorption of the nuclear recoils in the source material, it can degrade the energy resolution and can produce peaks with unpredictable shapes.

Like in alpha spectrometry, electrodeposition of the source would be preferable to minimize the self-absorption. Nevertheless, it adds more complexity to the technique and the electrodeposition yields change the proportion of the different elements. Drop and dried deposition of solution is simpler, but it makes sources with inhomogeneous salt crystals with micrometric dimensions. In order to keep the simplicity of drop deposition and to overcome the problem of the source quality, we develop nanoporous gold (NPAu) in which the source solution is dried in a nanometric scale.

A MMC prototype was built with an absorber containing the NPAu and a mixture of Pu isotopes. The synthesis of the NPAu with pores sizes of few tens of nm will be presented with SEM images. In addition, the tests of wetting with radioactive solutions will be shown. From the Q spectrum, the composition of Pu isotopes and other actinides was measured; it is in very good agreement with the reference values given by alpha and mass spectrometry. The Q peak shapes are identical and described by the convolution of a Gaussian and a sum of two left-sided exponentials. However, the FWHM resolution of 7.2 keV is far from the expected resolution of the detector (~1 keV). We will discuss how to improve it in the future sample preparation.

Less than 5 years of experience since completion of Ph.D

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