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Improved source/absorber preparation for radionuclide spectrometry based on low-temperature calorimetric detectors

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Energy-dispersive low-temperature detectors (LTDs) enable radionuclide spectrometry with energy resolutions exceeding by far those of conventional detectors such as Si(Li) detectors. Also, the energy threshold of radionuclide spectra can be much lower than with conventional techniques. Within the European Metrology Research Project "MetroBeta", beta spectrometry based on metallic magnetic calorimeters (MMCs) and radionuclide sources embedded in absorbers have been developed. Since this technique requires compatible source/absorber elements that provide optimal detection efficiency and avoid spectrum artefacts, new preparation techniques for reliable source/absorber fabrication have been established and tested.
Laser cutting and milling techniques are used to format noble metal foils with thicknesses ranging from 15 µm to 300 µm into arrays of absorber elements with lateral dimensions of about 0.6 mm to 3 mm. Automated microfluidic dispensing is used to deposit patterns of droplets of the radioactive solution onto the absorber elements. Individual droplet volumes of < 200 pl can be achieved with a high lateral placement accuracy. In this way, a well-defined activity is placed avoiding the formation of large crystals when salt-based carrier solutions are used. Subsequently, the radioactive material must be completely enclosed by the absorber material to ensure the detection of each beta particle and the absorption of the complete decay energy. Diffusion welding of matched absorber elements has been applied to realize such 4π source/absorber configurations. Temperature, pressure and processing time were varied to find best conditions that ensure ideal diffusion welding. It was found that this process strongly depends on the source and absorber materials.
The contribution will discuss the details of the source/absorber preparation techniques developed within "MetroBeta"as well as its quality control by means of radiographic imaging and contamination measurements.

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

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