Contribution ID: **50** Type: **Poster**

Investigation of sealed Cm-244 neutron sources from nuclear forensics aspect using non-destructive methods

Eight Cm-244 sealed radioactive sources (example: Figure 1.) with unknown origin were investigated by non-destructive methods from nuclear forensics aspect including physical characterization, handheld X-ray fluorescence (XRF), high resolution gamma-ray spectrometry (HRGS) and X-ray radiography. The goal of the research was to carry out origin assessment, to find key parameters and to test the relevant evaluation methods in case of the forensic investigation of Cm-244 sealed sources.

During the physical characterization procedure, pictures were taken with conventional camera (forensic photography) and optical microscope to analyze the surface and the morphology of the sealed sources. The dose rates were measured from 0.1 m and 1.0 m distances. Physical characterization is a routine procedure in nuclear forensics which is relatively quick and can provide essential information for the investigation, e.g. serial number, isotope and activity by observing the capsule (Figure 1.); and method of application from the structure (see beryllium windowing in Figure 2.a).

Figure 1: 0723LM Cm-244 sealed source under optical microscope

Figure 2: 0723LM Cm-244 sealed source

The main chemical composition of the capsules was determined by using a handheld XRF device. The analysis showed that the material of the encapsulations (Ni-Cu alloys) in the case of six out of eight sealed sources were very similar to each other, which may refer to a common production technology and/or the method of use. The other two sealed sources were Cu-Zn alloys.

In the measured gamma-ray energy spectra, the decay products and some prominent fission products of the present curium isotopes (Cm-243, Cm-244, Cm-245) were identified. Furthermore, age dating method was successfully tested – which was originally developed for Cf-252 [Apostol et. al., 2019]. This age calculation is based on the evaluation of the Cs-137 and I-132 fission product photopeaks (661.7 and 667.7 keV, respectively). The results were well acceptable which means the deviations of the values were within 1 year in the case of 25-35 years old sources. In addition, the absolute activities of Cm-244 sources were estimated (it was assumed that the radioactive sources could have been considered as point sources) and they were compared with the "computed" activities derived from the initial activities on the certificates (the deviations from the "computed" activities were on average 20%) and the activity ratios of some detected curium and neptunium isotopes (Cm-243/Cm-244, Np-239/Cm-243, and Np-239/Cm-244) were calculated. The research also aimed to search for signs of any unusual contamination which could be linked to the manufacturing process. In the case of two samples the 333.4 keV and 388.2 keV gamma energy peaks of Cf-249 were found.

Some X-ray radiographic pictures of the sealed curium sources were also taken, based on which the presence of tungsten shielding in sealed radiation sources could be confirmed.

This research presents results about the combination of non-destructive techniques used to analyse sealed neutron sources, which contributes to the expansion of the nuclear forensic library in Hungary.

Reference

Apostol, A.I., Zsigrai, J., Bagi, J., Brandis, M., Nikolov, J., Mayer, K. Characterization of californium sources by gamma spectrometry: relevance for nuclear forensics. J Radioanal Nucl Chem 321, 405–412 (2019). https://doi.org/10.1007/s10967-019-06628-0

Primary authors: SOÓS, Krisztián Roland (Nuclear Security Department, Centre for Energy Research); KIRCHKNOPF, Péter (Nuclear Security Department, Centre for Energy Research); DOSA, Gergely (Nuclear Security Department, Centre for Energy Research); ALMÁSI, István (Nuclear Securtiy Department, Centre for Energy Research); HLAVATHY, Zoltán (Centre for Energy Research); VÖLGYESI, Péter (Nuclear Security Department, Centre for Energy Research)

Presenters: SOÓS, Krisztián Roland (Nuclear Security Department, Centre for Energy Research); VÖLGYESI, Péter (Nuclear Security Department, Centre for Energy Research)

Session Classification: Poster Session 1

Track Classification: 1. Nuclear Forensics Capability Building: Initiation and Sustainability: 1.2 New Technologies, R&D and Signature Research in Nuclear Forensics