

A novel methodology for Nuclear Forensic Examination: Positron Annihilation Spectroscopy

The Positron Annihilation Spectroscopy (PAS) is a well known and widely used analytical technique in the material science. PAS is typically used to measure structure defects in the materials, e.g. to determine material defects in various metal alloys or the molecular structure of medicines. This is also why it is used in nuclear industry to study the material structure of irradiated metal alloys and many other types of materials, where it is necessary. The use of PAS for the measurements of nuclear materials is partially limited. It is because the measurements of nuclear materials by PAS is primarily dependent on the radioactivity of the test material, as its magnitude increases the background of the PAS spectrum. This impairs the detection limit of the instrument.

In nuclear forensic examination, PAS has not been used as an analytical equipment before. However, since the data provided by PAS are based on molecular structure, it may be suitable for origin assessment for nuclear materials.

In our research, we are looking for answers to decide, whether PAS is suitable for measuring nuclear materials for origin assessment, or not. Can it be useful in nuclear forensic measurements as a novel alternative instrument, or not? Therefore, various uranium ore concentrate and uranium oxide samples of known origin were examined by PAS. Based on the obtained results, the study of electron momentum distributions by Doppler-broadening spectroscopy has not revealed significant differences between the samples. Nevertheless, uranium oxide and the uranium ore concentrate samples could be distinguished easily and, also, positron lifetime data made differences even inside a group of samples.

Based on our results we can conclude that the PAS is a suitable instrument for performing nuclear forensic measurements.

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