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Application of SIMS and SEM to analysis of environmental swipes for nuclear safeguards

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Secondary ion mass spectrometry (SIMS) is one of the analytical techniques used by the International Atomic Energy Agency for the analysis of environmental swipes (ES) for uncovering undeclared nuclear materials and activities. A combination of imaging and mass separation capabilities of SIMS are used for finding particles of interest (containing U/Pu) amidst large amount of non-specific dust and for the determination of isotopic composition. The advantage of analyzing individual particles, compared to processing the whole swipe, is in the impossibility to mask the technology or history of inspected nuclear material by mixing or dilution with a material of varying enrichment.

However, the ES often contain more than one enrichment populations and the situations when two uranium particles with different enrichment are too close to be distinguished by SIMS imaging are not exceptional. Consequently, the results for some particles may be affected by isotopic mixing of two or more enrichments. In this work, we used a combination of SIMS and SEM (Scanning Electron Microscopy) for analyses of inspection swipes, and employed the procedures of correlative microscopy, which enabled observation of identical areas by both instruments. First, fast uranium particle search was carried out using SIMS and particles that could produce mixed isotopic compositions were identified. Next, the sample was transferred to SEM and the morphology of those particles inspected. The particles that were a part of a cluster or were within the distance of 10 ⊠m or less from other particles were excluded from the next step of the procedure –the SIMS measurement of isotopic ratios at high precision and accuracy. The procedure enabled for more accurate interpretation of the results of the inspection swipe analyses.

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