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Measurement and validation of the isotopic composition in inhomogeneous samples by LA-MC-ICP-MS

Introduction
Uranium-bearing materials are strictly controlled by the international nuclear safeguards system. However, if such materials get out of regulatory control and subsequently confiscated, a comprehensive characterization is required to assess the hazard, to determine the intended use and the potential origin. Nuclear forensics focuses on the analysis of these intercepted nuclear or other radioactive materials to provide information for the investigating authority to avoid the diversion and subsequent malicious use [1-3].
Most of the nuclear forensic samples contain visible or non-visible inhomogeneity, which can be exploited for potential nuclear forensic conclusions. One of the available micro-analytical techniques for such measurements is laser ablation inductively coupled plasma mass spectrometry with simultaneous detection (LA-ICP-MS) [4,5]. As LA uses a focused laser beam scaled down to a few micro-meters, LA-ICP-MS analysis can reveal sample inhomogeneity in the material in question and is able to measure the spatial distribution of the isotopic composition. However, the precise measurement can be hindered by instrumental parameters (e.g. laser beam size or scan speed) or by the sample characteristics (e.g. grain size or differences in U isotope enrichment) [6].

Present Work
The present work examines the nuclear forensic value of U isotopic inhomogeneity for by LA-ICP-MS measurements. To study the important parameters, a synthetic sample was prepared by the mixing of two solid certified standard materials (SRM U-010 and SRM U-030) to mimic an inhomogeneous U sample. By a rough LA measurement using a line scan or a 2-D area (map) on the sample surface, the points-of-interest in the inhomogeneous sample can be found and chosen (localization). After finding the required sample position, a more precise measurement can be performed on the selected small locations. The procedure allows the accurate analysis of the isotopic composition at the relevant spots and the proper identification of the end-products (i.e. the constituting starting materials). The developed LA-ICP-MS method was also compared with the large-geometry secondary ion mass spectrometry.

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