Isotopic and elemental characterization of nuclear and radioactive materials at the micrometric scale

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Nuclear Safeguards and Detection of Undeclared Activities

Context

- Within the framework of the **Nuclear Non-Proliferation Treaty** (NPT), IAEA inspectors collect particulate matter within nuclear facilities. Elemental and isotopic characterizations of traces of nuclear materials (NM) are crucial for **detecting clandestine nuclear activities**.

IMS 1300-HR³ methodology

- **Accurate isotopic measurements** make it possible to distinguish natural, depleted, enriched, or reprocessed **uranium**, providing essential insights into the material's origin and potential use.
- Further measurements, such as **age dating** or the search for specific activity marker elements, can be used to determine the industrial origin of the NM.

Advantages

- **Automated particle mapping** combined with the **multi-collection device** of LG-SIMS, allows detecting and characterizing (sub)micrometer sized uranium particles.
- **Lateral resolution**, thanks to a focus primary beam, allows analyzing heterogeneous samples and measure individual particle.

Environmental Analysis in Case of Nuclear Accident Contamination

Context

- The discovery of a new kind of radioactive particles, **CsMPs,** emitted during the Fukushima accident, led scientist to study **their formation mechanism** in order to understand the interactions between nuclear fuel and internal reactor structures. These particles may also be used as post-accident tracking indicators, allowing assessment of the **impact of radioactive contamination in the environment**.

IMS 1300-HR³ methodology

- With appropriate **Relative Sensitivity Factor**, RSF, corrections, **LG-SIMS** analyses allow the quantification of trace elements.
- The **multi-technique characterization** of the particles synthesized in the laboratory, combining SEM, TEM and LG-SIMS, supports the molten core-concrete interaction, MMCI, as a mechanism for the formation of the actual CsMPs.

Advantages

- The **LG-SIMS imaging capability** combined with its very **high sensitivity** make it a complementary tool to the SEM for detecting traces of elements.
- Quantitative information can be obtained allowing comparison between samples

QUICK TIPS

For high performance SIMS Characterization:

- **Maximize Sensitivity**: Use high primary ion density and automated particle mapping to enhance isotopic ratio precision and trace element detection.
- **Adjust the mass resolution power**: Optimize the peak shape at a given MRP to reduce isobaric interferences while improving measurement reproducibility.

Learn more:

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