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Single Particle Uranium Analysis by Triple Quadrupole Time of Flight Mass Spectrometry for Nuclear Forensics

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The International Atomic Energy Association's (IAEA) Network of Analytical Labs (NWAL) performs particle analyses from swipe samples for the monitoring of nuclear facilities and the radioactive material with two major focuses: detection of uranium bearing particles, and confirmation of declared enrichment.
Currently this analysis is carried out by large geometry secondary ion mass spectrometry (LG-SIMS) or fission track thermal ion mass spectrometry (FT-TIMS). Analysis using these instruments is both expensive and time consuming. In addition, FT-TIMS requires access to neutrons for irradiation, a site-specific requirement that heavily limits its availability. The number of samples needing analysis by NWAL is increasing rapidly, heavily taxing their resources. A faster analytical method is necessary to keep up with the growing number of samples.
The Penn State REACTR lab has acquired a Nu Vitesse inductively-coupled-plasma time-of-flight mass spectrometer (ICP-TOF-MS) with a triple quadrupole addition. The Nu Vitesse time of flight system has a very fast spectral acquisition speed which allows it to differentiate suspended particles from solution. Combined with an Image Geo 193 laser ablation system, this instrument is capable of performing spatially resolved isotopic and chemical analysis of solid samples. Both functions are of particular interest for testing IAEA swipes, and warrant investigation.
With the fast spectral acquisition capability of the ICP-TOF-MS and the laser ablation capability this system provides two possible approaches to analyzing uranium particles on IAEA swipes. The first approach involves pulling particles off the cotton swipe to create a suspension which can be analyzed directly by the machine. The second approach involves using the laser ablation system to map and ablate individual particles and collect their individual make up with the detector. Both methods provide the ability to measure the individual chemical and isotopic make up of particles, information that is useful for detecting anthropogenic sources of uranium.
The Nu Vitesse system should offer an improvement to speed and cost relative to the current systems used by NWAL. In addition, The time-of-flight mass spectrometer provides the ability to corelate particle composition with uranium isotopic abundance.

Author: ROMERO, Michael (Pennsylvania State University)

Co-authors: Mr GAGAN, Adam (Pennsylvania State University); Dr SCHWANTES, Jon (Pennsylvania State University)

Presenter: ROMERO, Michael (Pennsylvania State University)

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