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Capabilities of Hybrid SIMS-SSAMS System for Nuclear Forensics Applications

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Mass spectrometry of particulate samples by Secondary Ion Mass Spectrometry (SIMS) is a very useful tool for nuclear forensics. However, there are limitations from interferences caused by molecular species, such as 238U1H while measuring 239Pu. These interferences (> 104 M/ΔM) can exceed the resolving power of SIMS. Accelerator Mass Spectrometry (AMS) is capable of eliminating such molecular ion interferences, but this technique does not provide spatial information and generally requires use of negative ions. This requirement limits its sensitivity, since actinide and lanthanide elements preferentially generate positive atomic ions (~104 : 1). The US Naval Research Laboratory (NRL) has just installed a hybrid SIMS-AMS system, using a Single Stage AMS (SSAMS) as a replacement for the normal electron multiplier detector for a Cameca IMS 4f SIMS. The NRL design enables analysis of either positive or negative ions. Thus, this system offers the potential to provide SIMS-like particle analysis, but without the forest of signals from molecular species, and while measuring positive atomic ions. This should improve the sensitivity and precision of measurements to determine isotopic distributions of actinides and lanthanides, as well as elemental abundances of trace species in particles or small features to be mass analyzed. Initial measurements show the concept to be solid, with optimal operating conditions to be determined. Issues such as the charge state distribution, molecular ion destruction efficiency, beam broadening, beam transmission, and detection efficiency need to be addressed for quantitative analysis. This presentation will describe the concept, its benefits and limitations, and consider how it may find broader use. Examples from initial measurements will be presented.

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