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Mass Spectrometry in Nuclear Forensics

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Mass Spectrometry in Nuclear Forensics

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Illicit trafficking/smuggling of nuclear materials is of great concern in the present day scenario. This involves measurements on interdicted nuclear materials to trace their origin and to detect undeclared nuclear activities. Uranium and plutonium of different isotopic abundances produced during isotopic enrichments, reactor irradiations and after fuel reprocessing need be determined in variety of samples including swipe samples.
A variety of nuclear analytical techniques are being developed and used for their applications in nuclear forensics. These include different kinds of mass spectrometry, radiometry (alpha and gamma spectrometry), morphological investigations using SEM/TEM and other techniques like laser induced breakdown spectroscopy (LIBS), portable X-ray Fluorescence (XRF). Amongst these, inorganic mass spectrometry occupies a unique place for determination of isotopic composition and amount of U/Pu as well as other trace constituents present in the nuclear material. Different chronometers are being developed/tested worldwide to determine the age of the intercepted materials since its last purification. Natural variations in the isotopic composition of oxygen (O), sulphur (S), strontium (Sr) and lead (Pb) hold the potential to provide information about the geo-location of the material. Some of the examples available in the open literature on these studies will be presented during the talk.
The availability of data base from different producers as well as confidence in determining these data accurately is of great concern. Demand on the higher accuracy of some of the half-lives of actinides isotopes will be highlighted. The need to develop and test different spikes e.g. Pa-233, Pa-231, U-234 etc. for use in isotope dilution mass spectrometry would be discussed. Brief summary of the novel methodology developed in our laboratory for accurate determination of Pu-238 by thermal ionisation mass spectrometry to overcome the ubiquitous isobaric interference from U-238 will be presented along with the results on some synthetic mixtures. These studies will be useful to enhance the confidence in the forensic data generated using 238Pu-234U chronometer, particularly in Pu samples of high burn-up.

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