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MASS SPECTROMETRY FOR ISOTOPE RATIO MEASUREMENTS AND CONCENTRATION DETERMINATION

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Mass Spectrometry is a powerful analytical tool for isotope ratio measurements of different elements starting from hydrogen. The isotope ratios can be used to arrive at useful information about different parameters including concentration of the major, minor, trace and ultratrace constituents, half-life, cross-section etc. A number of elemental mass spectrometry instruments including Thermal Ionisation Mass Spectrometry (TIMS), Spark Source Mass Spectrometry (SSMS), Glow Discharge Mass Spectrometry (GDMS), Inductively Coupled Plasma Mass Spectrometry (ICPMS) and Secondary Ion Mass Spectrometry (SIMS) are commercially available and are being employed for different applications in nuclear science and technology, geo-chronology, electronics industry, environmental and biological sciences etc. During the last decade, the ultrasensitive techniques like Resonance Ionisation Mass Spectrometry (RIMS) and Accelerator based Mass Spectrometry (AMS) have been developed and used for measuring large isotope ratios (less than or equal to 10 exp -12) and for achieving sensitivities approaching single atom detection.

In our laboratory, TIMS and SSMS have been used for different applications. TIMS has been developed and used for isotope ratio and concentration determination of different elements like Li, B, Mg, Nd, Sm, Pb, U, Pu etc. required for different applications. Oligoelement analysis, use of molecular ions and preferential evaporation and ionisation methodologies have been developed and used to fulfill the objectives of achieving high precision and accuracy in the data and also performing measurements with high sensitivity. Half-lives of a number of transactinium isotopes (e.g. Pu-241) have been determined with the best possible precision and accuracy. Tracer techniques have been developed for different applications. Isotope Dilution (ID) technique has been used for determining trace elements in biological samples. The isotope ratio and concentration data of Nd and Sm have been used for geochronology studies on mafic and ultramafic rock samples.

The technique of SSMS has been developed and used for trace elements determination in different matrices. Basic investigations have also been carried out to correlate the experimentally determined Relative Sensitivity Factors (RSFs) with the thermodynamic parameters. Experiments have been carried out to study the formation of cluster ions as well as multiply charged species.

Efforts are in progress to use GDMS, ICPMS and SIMS in future for various applications. We are also working on the development of an RIMS system using Reflectron based Time-of-Flight system with lasers for selective ionisation of the atomised atoms. With the availability of FOTIA (Folded Tandem Ion Analyser) with maximum terminal voltage of 7 MV, it is planned to develop and use AMS.

The present talk would highlight the different activities being pursued in elemental mass spectrometry. Specific examples/applications of the work performed in our laboratory would also be presented.