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Foreword

Since many decades mass spectrometry involved an outstanding position under the analytical techniques due to universality and possesses wide application fields in atomic physics chemical reactions analysis in ion molecular chemistry, study of kinetics of chemical processes or determination of thermodynamic data. A main feature of mass spectrometry is the determination of the exact mass of isotopes and precise and accurate isotopic abundances or isotope ratios. The importance of isotope ratio measurements by mass spectrometry has increased in the last few years due to a significant improvement of analytical techniques with respect to sensitivity, detection limits, precision and accuracy. One of the challenging tasks of analytical chemistry is especially the determination of small abundances of stable isotopes and long-lived radionuclides at trace and ultratrace concentration levels. Furthermore, the study of very small isotope variation in nature and in environmental science (environmental monitoring), in geoscience (geochemistry and geochronology), cosmochemistry and planetary science and in nuclear science (for the quality assurance of fuel material and for radioactive waste control) etc is of increasing importance. A number of publications including reviews focuses on isotope ratio measurements using different mass spectrometric techniques in the last few years (such as inductively coupled plasma mass spectrometry (ICP-MS) and laser ablation ICP-MS (LA-ICP-MS), thermal ionization mass spectrometry (TIMS), accelerator mass spectrometry (AMS), resonance ionization mass spectrometry (RIMS), secondary ion mass spectrometry (SIMS), glow discharge mass spectrometry (GDMS), and gas isotope ratio mass spectrometry (IRMS) in respect to methodological and instrumental developments, novel approaches and different applications). From the discussed mass spectrometric techniques ICP-MS has a superior place resulting in an exponential proliferation of research and publications. Several papers concern on development of analytical techniques using multicollector inductively coupled plasma mass spectrometry (MC-ICP-MS) which permits the precise measurement of the isotope compositions for a wide range of elements combined with excellent limits of detection due to high ionization efficiencies. MC-ICP-MS and double-spike TIMS permit to determine small variations in isotopic composition. New studies on iron isotopic composition of human blood and dietary iron sources have shown that lighter iron isotopes are enriched along the food chain and that each individual bears a distinct iron isotopic signature in blood whereby possible mechanisms for inducing an iron isotope effect at the cellular and molecular level during iron uptake is discussed.

Progress was also achieved in geological research or determination of long-lived radionuclides as demonstrated in different papers. Methodical developments for measurement of transient signals, e.g., by online high-performance liquid chromatographic separation system coupled to a MC-ICP-MS in order to overcome isobaric interferences for the determination of the plutonium isotope composition and concentrations in the presence of ^{238}U as the main component in irradiated nuclear fuels or studies on GC-MC-ICP-MS were described.

For the direct isotope ratio measurements LA-ICP-MS is used for microanalytical characterization of reference glasses, for determination of halogens in powdered geological and environmental samples using isotope dilution technique or for uranium isotopic ratio measurements in biological samples using a cooled laser ablation chamber.

Furthermore, isotope ratio measurements is focussed on tracer experiments and application of isotope dilution technique in species studies. Tracer experiments using enriched stable isotopes in LA-ICP-MS in combination with MALDI-FTICR-MS opened a new area in study of metal-containing proteins.

This special issue concerns on the growing significance of mass spectrometry on isotope ratio measurements in quite different application fields of analytical chemistry.

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