

ACCURATE, PRECISE AND RAPID MEASUREMENT Pb, Th, Hf, W AND Os ISOTOPES BY HIGH ABUNDANCE SENSITIVITY MULTIPLE COLLECTOR INDUCTIVELY COUPLED PLASMA MASS SPECTROMETER (MC-ICPMS): A REVIEW OF METHODS, RESULTS, AND APPLICATIONS

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Substantial advances have recently been made in high abundance sensitivity multiple collector inductively coupled plasma mass spectrometry. Micromass Isoprobe with hexapole collision cell interface, yields an ion beam with *ca.* 1 eV energy and produces flat topped peaks across a multi-collector FC array. Isoprobe thus enables precise isotopic ratio measurements to be obtained for most elements in the periodic table, particularly for those with high ionization potentials. The ICP source has several advantages over conventional solid-source thermal ionisation mass spectrometers (TIMS) because of its high ionization efficiency for all elements except Sr. In addition, the plasma source and hexapole collision cell eliminates molecular isobaric interferences (Ar, ArAr, ArO and ArH) because these isobaric species are unstable in this ionizing and ion optical environment. Thus Isoprobe provides a platform for rapid, precise, accurate, and cost-effective measurement of elements that are difficult to analyze by TIMS, such as Hf, Th, Re, W, and Os. The extended geometry magnet design and wide flight tube of the magnetic sector allows implementation of a wide dispersion Faraday Cup-electron multiplier-ion counting multiple collector that enables synchronous measurement of U and Pb.

Isoprobe sensitivity of $>1 \times 10^{10}$ cps of Pb^+ per ppm of Pb is 10 orders-of-magnitude greater than achieved by ion microprobe (e.g. SHRIMP). This represents an efficiency of 1 ion:130 atoms. High precision, Tl normalised, Pb isotope ratio measurements of NBS 981 by MC-ICPMS, have yielded reproducibilities comparable with data from TIMS. However, accuracy of the measurements is not comparable with double or triple spike TIMS data. To resolve this problem 50 ppb solutions of NBS 981 and 982 spiked with 5 ppb Tl were analysed at UQ. Total Pb ion signals of 12 volts are obtained with CETAC MCN6000 and Aridus desolvating nebulisers. When baselines are measured at ± 0.5 amu, Pb isotope ratios were identical to other MC-ICPMS data. However, when on peak zero (to correct for Hg in the Ar) and ± 0.5 amu baselines are combined and subtracted from the ion signal analyses NBS-981 and 982 standards yielded results within error of double and triple spiked TIMS data. These results and data for 12 ng solutions of NBS 983 $^{206}Pb/^{204}Pb = 2700.4 \pm 19.5$ (1_) demonstrate that accurate and precise isotope ratios of Pb can be obtained using measured Tl isotope compositions and a power law fractionation correction, providing attention is paid to correct blank subtraction.

Sensitivity for Th is $>3.7 \times 10^9$ cps (1 ion:345 atoms). By contrast, the best efficiency achieved by TIMS is 1 ion:2000 atoms. Measurements of UCSC Th_ on Isoprobe with a WARP filter and an ion counting Daly detector has yielded identical results in 5 minutes consuming <3 ng Th than were achieved with 250 ng of Th by TIMS viz., $^{232}Th/^{230}Th = 170,539 \pm 1478$ (2_) - Isoprobe cf. $^{232}Th/^{230}Th = 170,545 \pm 1345$ (2_).

Hf and combined W-Re, Re-Ir and Os-Ir isotope ratios determined by Isoprobe will also be presented. Precise, accurate and rapid determination of isotopic compositions by Isoprobe will have a major impact on Earth, Environmental, Health and Forensic Science, as well as for the discipline of Metrology.