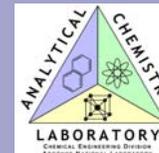


Inductively Coupled Plasma Mass Spectrometry (ICPMS) Capabilities and Applications

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ICPMS Overview

Inductively coupled plasma mass spectrometry (ICPMS) is the most powerful technique for the analysis and quantification of trace elements and isotopes in both liquid and solid samples. It can be used for most elements with the exception of H, C, N, O, and gaseous elements. Samples need to be introduced in liquid form with less than 0.2% total dissolved solid. Solid samples must be dissolved or extracted in acid prior to ICPMS analysis.

- Sample Volume**
Typically 3-5 mL
~200 uL with use of micro flow nebulization

- Detection Limit**
Depends on the element, sample matrix, introduction technique and instrument condition

Quadrupole ICPMS: ~ 0.1 ppb (ug/L)
High-Resolution ICPMS: ~ 1 ppt (ng/L)

- Accuracy**
Within 10% for multi-element analysis (the most commonly used method)
3% or better for isotopic dilution analysis
Within 50 % for semi-quantitative analysis

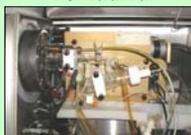
- Applications**
Environmental analysis, water treatment, geological application, clinical analysis, material science, semiconductor industry, spent fuel analysis, nuclear forensic analysis



ICPMS Operation

- Sample is dispersed into a stream of gas and injected into high-temperature plasma.
- Sample is desolvated, atomized and ionized.
- The plasma core containing the sample ions is extracted into a reduced-pressure region through two orifices.
- Positive ions are extracted and transported through an ion lens system.
- Ions are separated according to their mass-to-charge ratio by a quadrupole mass filter or by a double focusing mass spectrometer.
- Individual ion is detected by an electron multiplier or a Faraday detector.
- Data are transferred to a computer data system.

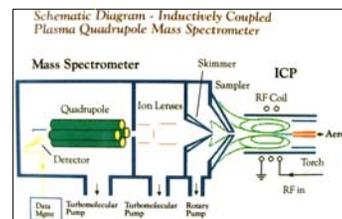
ICP Torch Box



ICPMS Mass Spectrum



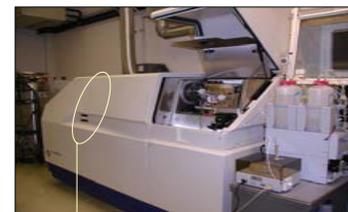
Fisons PQII+ with Quadrupole Mass Spectrometer



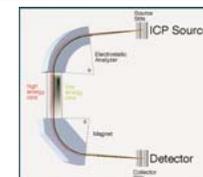
Quadrupole ICPMS

- Trace analysis (ppb-ppm)
- Broader calibration range
- Faster analysis time
- Good screening tool

VG Elemental Axiom High-Resolution ICPMS with Double Focusing Mass Spectrometer



Double Focusing Mass Spectrometer



High-Resolution ICPMS

- Ultra-trace analysis (ppq-ppb)
- High sensitivity and low noise
- Resolves most isotopes from any molecular species
- Smaller sample volumes (200 uL)

High-Performance Liquid Chromatography—Inductively Coupled Plasma Mass Spectrometry (HPLC-ICPMS)

Use HPLC for on-line chemical separation prior to ICPMS detection to eliminate isobaric interferences. Methods have been developed for separation of individual lanthanides and actinide elements. (Dean Bass and Margaret Goldberg)

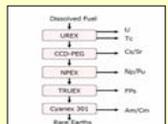
ICPMS Applications in Chemical Engineering Division

UREX+ Process for Spent Fuel Treatment

Develop advanced fuel reprocessing systems that separate key radionuclides from spent fuel followed by superior waste-disposal forms and/or transmutation of long-lived isotopes. (George Vandegrift and Monica Regalbuto)

ICPMS Analysis

- Provided chemical/isotopic composition of all of the processing streams including feeds, intermediate stages and products.
- Data were used to evaluate the efficiency of different separation processes.

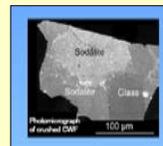


Qualification of Ceramic and Metallic Waste Forms

Conduct laboratory tests to support the qualification of ceramic and metallic high-level radioactive waste forms for disposal in the Yucca Mountain repository. (William Ebert)

ICPMS Analysis

- Measured the concentrations of waste form constituents (B, Na, Si, Pu, and U) in solutions generated under different test conditions.
- Provided a primary data base for measuring waste form behavior and qualifying the waste forms for disposal.

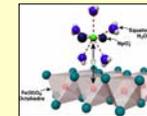


Adsorption of Neptunium onto Steel Corrosion Products

Develop a predictive model for the sequestration of neptunium by iron oxides that involves reacting neptunium-bearing aqueous solutions (simulated groundwater) with iron oxide mineral powders. (James Jerden)

ICPMS Analysis

- The concentrations of Np, U and Fe in the solutions before and after the reaction were measured to determine how much neptunium was adsorbed onto the iron oxide mineral.



Stability Study of Platinum Based Electrodes Used in Polymer Electrolyte Fuel Cells

Investigate the electro-dissolution of platinum in acidic media to understand the mechanisms leading to the loss of electrochemically active surface area. (Xiaoping Wang)

High Resolution ICPMS Analysis

- Measured the Pt concentrations of samples in different electrolyte solutions at various potentials and temperatures with detection limit of Pt at ~ 1 ppt.



Conclusions

ICPMS is a powerful and affordable technique for determination of elements and isotopes in solutions. It can be applied in a broad range of research areas. With strong ICPMS capabilities, the Analytical Chemistry Laboratory in Argonne's Chemical Engineering Division can provide accurate measurements with fast turnaround time to meet your research needs.