Inductiveli coupled plasma mass spectrometry (ICP-MS)

Schedule:

Week 1: Introduction to the World of ICP-MS

Historical overview and technological development. How does ICP-MS differ from ICP-OES? When is ICP-MS necessary? The role of ICP-MS in modern analytical chemistry. Typical application areas (environmental, geochemical, food, clinical, nanotechnology).

Week 2: Fundamentals of Plasma Physics

Structure of the ICP, excitation mechanisms, energy transfer, ionization processes, physical basis of matrix effects. Plasma stability and common problems. Role of the interface region.

Week 3: Ion Optics and Mass Spectrometer Architecture

Ion guidance, comparison of quadrupole, time-of-flight, and sector field systems. Detectors. Mass filtering and resolution.

Week 4: Sample Introduction and Sample Preparation

Nebulizers and spray chambers. Aerosol formation and transport processes. Common issues arising from sample introduction. Special introduction techniques: desolvation, laser ablation, HPLC-ICP-MS hyphenation. Sample preparation strategies. Role of acids and solvents.

Week 5: Spectral and Non-Spectral Interferences

Isobars and polyatomic interferences. Oxide and hydride formation. Influence of plasma parameters. Non-spectral interferences: matrix effects, ionization suppression. Strategies to reduce or eliminate interferences.

Week 6: Collision and Reaction Cell Technologies

Use of collision and reaction cells. Triple-quadrupole ICP-MS systems and their advanced analytical capabilities.

Week 7: Quantitative Analysis

External calibration and standard addition. Internal standards and drift correction. Linear dynamic range and detection limits.

Week 8: Quality Assurance and Method Validation in ICP-MS

Accuracy, precision, reference materials. ISO 17025 requirements for ICP-MS. Use of US EPA methods.

Week 9: Instrument Troubleshooting and Maintenance

Plasma instability. Sample introduction problems. Ion optics contamination. Daily/weekly/monthly maintenance protocols.

Week 10: Data Processing and Statistics

From raw signal to concentration. Background correction, outlier handling. Basics of multivariate statistics for ICP-MS datasets.

Week 11: Speciation Analysis with ICP-MS

HPLC-ICP-MS and GC-ICP-MS. Speciation of arsenic, chromium, mercury. Stability issues and critical steps.

Week 12: Nanoparticles and ICP-MS

Single-particle ICP-MS. Theoretical foundations. Determination of particle size and number concentration. Typical errors and artefacts.

Week 13: Isotope Ratio Measurements and Geochemical Applications

MC-ICP-MS fundamentals. Mass bias corrections. Examples from geochronology and environmental geochemistry.

Week 14: Case Studies and Advanced Applications

Environmental analysis, biological samples, materials science examples. Joint discussion of participants' own analytical problems. Course summary.