REVIEW

Inductively Coupled Plasma-Mass Spectrometry: Practices and Techniques

Howard E. Taylor
Academic Press
San Diego, CA, USA
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Inductively coupled plasma-mass spectrometry (ICP-MS) continues to grow in popularity as one of the most successful elemental and isotopic analysis techniques. This book is billed as "presenting the basic elements of ICP-MS for the practicing analytical chemist". . . . "especially scientists who have not had previous exposure to this technology." The book is successful in fulfilling these goals.

This book covers the basic concepts for ICP-MS including plasma production, instrumentation, sample introduction, quantitation, sources of error and optimization in 160 pages of text. Several chapters cover practical issues including quantitation techniques, interferences and optimization, that are essential to obtaining high quality results. Appendices contain useful information including a list of first and second ionization potentials of the elements, isotopic abundances, prominent polyatomic interferences and a list of certified standard reference materials available from NIST (USA) and NRC (Canada). The book is easy to read and well written, so it would be a good introduction to the basic concepts of ICP-MS.

The "Introduction" outlines some of the capabilities of ICP-MS, a bit of its history, a list of currently-available commercial instruments and selected references to other books that cover ICP-MS in more detail. The second chapter briefly covers the Bohr model of atoms, isotopes and ionization at a level that is appropriate and useful to those not familiar with inorganic mass spectrometry. For example, because many elemental analysis techniques cannot distinguish different isotopes, analysts may be used to thinking in terms of average atomic weight rather than signals for a set of discrete isotopes. The third chapter covers plasma formation including generators and torches, a bit about lateral signal profiles for argon and analyte ion signals, plasma zones/temperatures and the element dependent extent of ionization.

The chapter on "Instrumentation" briefly describes the interface between the atmospheric pressure ICP and the mass spectrometer, different types of mass spectrometers (quadrupole, magnetic sector, time of flight, ion trap) and detectors. The chapters on "Sample Introduction" and "Special Techniques" cover a large number of techniques for gaseous, liquid and solid sample introduction along with flow injection, chromatography and field flow fractionation sample processing.

The chapter, "Quantitation Techniques" discusses qualitative, semi-quantitative and quantitative analysis. This chapter contains useful, practical information including suggestions on the composition of stock standard solutions and their shelf life and sets of elements that are compatible in mixed, multi-element solutions. Internal standardization, standard addition and isotope dilution methods are described. The isotope dilution description is particularly well done, with the level of detail that is often lacking for other topics in the book. Unfortunately, there is no discussion of which types of regression lines (linear unweighted, linear weighted, linear through zero) are appropriate depending on the concentration range of interest.

The chapter on "Interferences" nicely covers isobaric spectral overlaps, various types of polyatomic molecular spectral overlaps and doubly-charged elemental ions. Reaction/collision cells are briefly described and the author points out that the main types of ion-molecule reactions are charge transfer, proton transfer and hydrogen transfer. Unfortunately, the author fell into the trap of repeating claims that helium causes collisional dissociation of strongly bound polyatomic ions such as ArO^+. Even the manufacturer that originally made this claim has now noted that the removal of the ArO^+ is due to reactions with impurities in the He reaction gas. Nonspectral effects are classified as "matrix effects" and "physical effects" (orifice clogging, etc., due to sample deposition).

A chapter titled "Optimization" describes, in very general terms, experimental variables that can affect signals and includes a brief discussion of "cold plasma" operating conditions (that are sometimes used to reduce spectral overlaps when the interfering ion has a higher ionization energy than the analyte ion of interest). The final chapter, "Figures of Merit," discusses sensitivity (here defined as the calibration regression line slope divided by the signal standard deviation), detection limits, precision and accuracy. The discussion of accuracy centers on the use measurement of certified reference materials.

For my taste, the book's main weakness is the paucity of references within the text to provide the reader a route to more detailed information and avoidance of specifics to explain "why?". The text cites only 22 references. Often, a brief statement is made about a specific, interesting application of ICP-MS (sometimes even with data shown in a figure) with no citation.

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Perhaps with the current wide availability of on-line literature search engines, this is not as big of a problem as it first appears. The book does include 100 pages of supplemental references including titles, but these are not cited in the text so the reader would need to browse through it all to find specific information of interest. At several points the reader is left without information that would allow for better understanding. For example, the author states that an "appropriate hardware configuration (to control plasma potential)" is necessary for operation under cold plasma conditions, but there is no explanation of what plasma potential is or how it can be controlled.

In summary, this book is an easy to read introduction to ICP-MS. It takes a much different approach than the more detailed, practical example-filled *Handbook of Inductively Coupled Plasma Mass Spectrometry* by K. E. Jarvis, A. L. Gray, and R. S. Houk (1992, Blackie), which is unfortunately out of print and has not been updated. Taylor's book is certainly an easier introduction to ICP-MS than the deeply-detailed, *Inductively Coupled Plasma Mass Spectrometry* edited by Akbar Montaser (1998, Wiley-VCH), widely considered the "bible of ICP-MS." The book reviewed here is a good introduction to ICP-MS although it is not a reference book that users of ICP-MS would rely on.