BOOK REVIEW

Time-of-Flight Mass Spectrometry

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Book review by David M. Lubman
Department of Chemistry
The University of Michigan,
Ann Arbor, MI 48109

This volume on time-of-flight mass spectrometry (TOFMS) is a timely collection of articles in a very dynamic and expanding field. It is composed of articles derived from several symposia organized by Bob Cotter that include the 204th National Meeting of the American Chemical Society in Washington, DC, August 1992 and the Pittsburgh Conference in New Orleans in March 1992. The volume covers many of the innovations in TOFMS that have resulted in so many of the important applications that currently involve time-of-flight (TOF). This collection of articles, together with the volume of articles on TOF recently published by Schlag, provides a relatively comprehensive survey of modern developments in TOF analyzers and some of the important fundamental and biological applications that have resulted.

In Chapter 1 Dennis Price describes the history of TOFMS from its initial development and commercialization in 1955. This chapter is particularly enlightening in that it summarizes the many developments in TOF and its successes and failures. Price reviews the many contributions over the years that have led to the preeminence of TOFMS in the field of analysis.

In Chapter 2 Bob Cotter reviews the principles of time-of-flight mass spectrometry. This chapter does an excellent job of reviewing the basic principles of the Wiley–McLaren linear TOF instrument and the factors that determine the resolution, which include the spatial, kinetic energy, and temporal distribution of ions created in the TOF acceleration region and methods to improve the resolution that include time-lag focusing and desorption of ions from surfaces that use either pulsed laser sources or ion beam sources. In addition, other important factors that limit the resolution are reviewed in detail, most notably, metastable fragmentation, where detailed equations that review the effects of metastable decay on resolution and ion formation in various regions of the TOF are given. This chapter also does an outstanding job reviewing the principles of dual and single stage reflectrons and their role in the study of metastable decay. The equations that describe these phenomena are given in detail and many important subtleties of these methods are explained clearly. The chapter also covers tandem mass spectrometry in TOF devices, and there is some discussion of methods to record the TOF ion spectrum. This chapter serves as the key to reading this volume and is highly recommended for investigators starting out in this field.

In Chapters 3–6 the TOFMS as a tandem instrument is discussed. Several variations of the TOF configuration in combination with a second analyzer are discussed as a means to obtain structural information or enhance the resolution. In Chapter 3 Beavis discusses reflectron instruments, the various reflectron configurations, and their role in the analysis of metastable decay. In Chapter 4 Duncan describes a configuration for use of laser photodissociation of mass-selected ions in a reflectron TOF and various applications of this method to studies of metal-containing cluster ions. In Chapter 5 Russel describes a magnetic sector (EB)/re TOF developed in this group. Several elegant examples of the use of photodissociation with tandem mass spectrometry in this device to study fundamental reactions in clusters are discussed. In addition, the analysis of matrix-assisted laser description–ionization (MALDI) and secondary ionization mass spectrometry-produced ions and their metastable decay products by the EB/re TOF are reviewed. In Chapter 6 Cotter describes a dual-reflectron tandem TOFMS and discusses its role in collision-induced dissociation fragmentation studies and for resolution enhancement.

In Chapter 7 Dodonov describes the interface of a continuous electrospray ion source to a reflectron TOFMS. This is an important historical development in that it allowed a means to interface a continuous ion beam to a pulsed TOFMS. The details of the method and the factors that affect resolution are derived clearly in this chapter. Other variations of this idea have evolved to continue the important task of interfacing TOFMS to continuous ion beam sources.

In Chapters 8–10 several authors describe instrumental and data processing methods to improve TOF performance. In Chapter 8 Conzemius describes various desorption methods to generate small numbers of ions to improve the performance of TOF. In Chapter 9 Holland and co-workers describe their work on instrumental and data processing methods to improve the performance on gas chromatography interfaced to TOF. In Chapter 10 Lys describes methods in signal processing for TOF applications.

In Chapters 11 and 12 the authors discuss the use of TOF in biological applications. In Chapter 11 Amina Woods uses plasma desorption mass measurements following enzyme digestion methods to determine structure and phosphorylation sites in biological samples. In Chapter 12 Martha Vestling discusses various methodology to analyze proteins separated by gel electrophoresis via mass spectrometry. Among the strategies discussed is the use of blotting proteins separated

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by gels onto membranes for analysis by MALDI. The interfaces between MALDI–mass spectrometry and gel separations, which are nicely reviewed in this article, no doubt will continue to be a key area of research.

In conclusion, this volume does an excellent job of covering several of the key areas in TOF development and applications. Many of the chapters will continue to be useful as a resource for areas that presently are expanding rapidly and will be considered as the exciting areas in mass spectrometry. I highly recommend this book for investigators who wish to expand their research interests into this dynamic field. I would certainly recommend it as a source text for a graduate level specialty course in mass spectrometry.