



ELSEVIER

Journal of Chromatography A, 824 (1998) 247–249

JOURNAL OF
CHROMATOGRAPHY A

Book review

Solid-Phase Microextraction—Theory and Practice, by Janusz Pawliszyn, Wiley–VCH, New York, Chichester, Weinheim, 1997, XII +247 pp., price £50.00, US\$ 65.95, ISBN 0-471-19034-9.

This monograph, authored by the inventor of the technology, is the first to solely address solid-phase microextraction (SPME), and it constitutes the best book yet written about the novel technique. SPME is a solvent-free extraction technique in which chemicals partition from the sample into a liquid-polymer or solid sorbent phase coated on a small quartz or metal fiber. After the coated fiber is exposed to the sample via direct contact, headspace, or through a membrane, the “extract” is analyzed after analyte desorption in a GC, HPLC, or other system’s injection port. The greatest advantage of the approach over many traditional methods is its ease of use. All that has to be done is alternately expose the fiber to the sample and the injection port in a very consistent manner. There is no extraction solvent, no clean-up, no solvent evaporation, no glassware, no waste, and no manual labor if automated equipment is employed.

I am an analytical chemist who thrives on the evaluation of new technologies, and I relished this opportunity to review the book so that I could learn more about SPME. Prior to reading the book, I had read only a few papers on the topic, and I had seen the product information disseminated by the vendor. I was intrigued by the concept and very impressed by the ingenuity of the devices and revolutionary aspects of the technique, but I held a healthy skepticism about the overall utility of SPME. I had hoped my skepticism would either vanish or be affirmed as I read the book. I had wanted all my questions about

practical matters and diverse applications of SPME to be answered in a fell swoop.

The author presents the subject in six chapters and two appendices. The first chapter, “Solid Phase Microextraction in Perspective,” is a 9-page overview of “solvent-free” sample preparation techniques. Although this material is not especially important to the rest of the book, I felt that other techniques were not given a fair assessment by the author. Most striking were the two small paragraphs on solid-phase extraction (SPE) which did very little to inform the reader on the many advantages of SPE that have made it the most widely used sample preparation technique today. Instead, he cites problems that may occur in certain applications as general disadvantages of SPE, when in fact, SPE is so versatile in use and applications that it is difficult to make any generalizations. If SPME is to expand into other applications and challenge SPE as the sample preparation leader, it will have to utilize the current sorbent types common in SPE, and their “limitations.” The inaccurate categorization of sample preparation techniques and the omissions of matrix solid phase dispersion and direct sample injection in Chapter 1 are also subject to criticism.

Chapter 2, “Operating Principles and Construction of SPME Devices,” is designed to give an overview of SPME for the reader before the theory, practice, and applications are presented in more detail in Chapters 3–5. Much interesting information is presented in Chapter 2, such as a historical perspective and design of analytical interfaces, but in general, I found the discussion of SPME principles and operation to be disjointed. The material is much more organized and complete in the subsequent chapters. I think the presentation of this material would have

been improved if Chapters 1 and 2 were combined into a concise, organized overview of SPME and aspects of its use in comparison to other approaches. SPME is truly unique and the author did not put this into perspective as well as I envisioned.

Chapter 3, "Theory of Solid-Phase Microextraction," is a thorough, well-organized, and informative presentation of the physical and chemical processes involved in SPME. Fundamental equations are provided that describe the thermodynamic and kinetic relationships for a variety of situations in which SPME is applied. The author concludes the chapter with a concise summary of the theoretical relationships in SPME and provides experimental evidence to demonstrate the relationships. The chapter contains many helpful diagrams and figures that help define the parameters show the effects of individual parameters on the extraction and desorption processes. For interested readers, the book also contains a more fundamental description and derivatization of the equations in Appendix A. I believe the separate inclusion of this material was useful for both the mathematically-inclined and the empirical-minded readers. Depending upon the needs of the user and the application, SPME can be used empirically by comparing experimental results versus known systems, or through the use of the detailed equations provided in the book, fundamental parameters such as Henry's Law constants can be obtained from simple experiments.

My only concern with Chapter 3, however, is that the author assumes that the reader understands the distinction between absorption, as in gas-liquid chromatography, and adsorption processes in a solid phase. SPME can involve either absorption or adsorption depending on the fiber coating, and the two terms often appear interchangeably in the text which may confuse the less informed reader.

Chapter 4, "SPME Method Development," is also well-organized, thorough, and informative. Many of the issues that were mentioned with little explanation in Chapter 2 are described individually under bold-type subheadings. As in Chapter 3, a number of equations and figures are provided to clarify the important experimental factors to control when developing methods using SPME. Chapters 3 and 4 in conjunction provide the reader all the information they need to understand how SPME works and how

to develop methods and evaluate the technology in just about any potential application. To further help the novice user of SPME, Chapter 6, "Experiments," provides complete instructions for experiments in three previously tested applications concerning the analysis of organic contaminants in water and caffeine in beverages.

Chapter 5, "Applications," is organized into sections that include in part: environmental, food and pharmaceutical, clinical and forensic, and physico-chemical applications. Appendix B is a listing of all scientific articles on SPME up to 1996 categorized by subject. I believe the reader would benefit by obtaining copies of several of the publications that the author most often references and keeping these papers nearby as (s)he reads Chapter 5. The author presents many tables and figures, which significantly enhance the comprehension of concepts presented of the text, but in many instances, the captions and text do not provide a complete listing of pertinent information, such as sample types, analyte concentrations, SPME parameters, and method of analysis. Personally, I found the omission of many of these simple facts aggravating because I could not make an immediate, easy comparison of the SPME results with results from other techniques I know for the same application. The lack of this information in many cases fed my skepticism of SPME because I tended to assume the worst for an unlisted parameter.

There are three other criticisms in particular that I would like to make concerning the discussion. In general comparisons of SPME results with those from other methods, the author does not adequately reference the other methods for the reader, and he does not choose the most effective existing methods in the comparison. Secondly, the author states that best results for direct extraction of complex matrices are obtained through the use of isotopic derivatives of the target analytes as internal standards, but he does not note that the isotopic derivatives for many compounds are prohibitively expensive or nonexistent. Finally, the author and inventor of the ingenious new approach did not answer another fundamental question of mine, "Would he like the reader refer to SPME as 'es pee em ee' or 'spee mee' as I have heard others call it?"

After having read the book, I am pleased to have learned more about the theory and possibilities of

SPME than I had anticipated, but of course, due to the newness of the technique and lack of complete information, I can make no more concrete conclusions about the role of SPME in relation to other techniques than I could before I had read the book. At this time, it appears that SPME will find a niche as the most effective and efficient approach for the analysis of volatile organics in uncomplicated or consistent matrices. It will gain attention as an

alternative to liquid-based extraction, but as in supercritical fluid extraction, some trade-offs in polarity range and detection limits may have to be made to gain the practical advantages in the use of SPME. This excellent first book on the subject will serve well to promote SPME technology and expand its use in the analytical chemistry community.

Beltsville, MD, USA

Steven J. Lehotay