Ultrasound in Chemistry

Analytical Applications

Edited by
José-Luis Capelo-Martínez

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Library of Congress Card No.: applied for

British Library Cataloguing-in-Publication Data
A catalogue record for this book is available from the British Library.

Bibliographic information published by the Deutsche Nationalbibliothek
The Deutsche Nationalbibliothek lists this publication in the Deutsche Nationalbibliografie; detailed bibliographic data are available on the Internet at http://dnb.d-nb.de.

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Typesetting Thomson Digital, Noida, India
Printing betz-druck GmbH, Darmstadt
Binding Litges & Dopf Buchbinderei GmbH, Heppenheim
Cover Design Adam-Design, Bernd Adam, Weinheim

Printed in the Federal Republic of Germany
Printed on acid-free paper

ISBN: 978-3-527-31934-3

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Preface

The main reason for writing this book was the desire to promote the use of ultrasound as a tool for sample treatment more widely among the Analytical Chemistry community. This text is intended to serve as a laboratory guide in that it addresses the more practical aspects of the subject, reflecting the most important applications of ultrasound for sample treatment reported in the literature to date. This is definitely not a theoretical text.

Chapter 1 reviews the ultrasonic devices available nowadays to perform sample treatment for chemical analysis. Chapter 2 is devoted to applications of ultrasound for the extraction and determination of elements, including element speciation, in a wide variety of matrixes, whilst Chapter 3 is dedicated to the extraction and analysis of organic compounds. Chapter 4 covers the different uses of ultrasound in analytical electrochemistry. Chapter 5 is dedicated to the acceleration of sample treatments of one growing area in analytical chemistry: proteomics – this is one of the most recent applications of ultrasonic energy. Finally, Chapter 6 deals with further applications of ultrasonic energy, not only in analytical chemistry but in the general chemistry arena.

I thank Dr Heike Nöthe and Dr Manfred Köhl from the publishers, Wiley, who kindly proposed me the edition and writing of this book. I am also grateful to all the co-authors, Professor R.G. Compton, Dr N.V. Rees, Dr C. Lodeiro, Dr R. Rial-Otero and H.M. Santos, M.Sc.

Finally, we hope that you will find this text useful and that ultrasonic energy will become not only a routine laboratory procedure but also an exciting research field for analytical chemists.

Caparica, Portugal
October 2008

José-Luis Capelo-Martínez

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The Power of Ultrasound

Hugo Miguel Santos, Carlos Lodeiro, and José-Luis Capelo-Martínez

1.1
Introduction

During the last 20 years we have witnessed an amazing increase in the application of ultrasonic energy in different fields of science. This is especially true for analytical chemistry. The number of manuscripts devoted to almost all kinds of analysis dealing with the uses of ultrasonic energy continues to grow year by year. As the uses of ultrasonication have become increasingly important in analytical chemistry so to has the importance of the type of ultrasonic device chosen to work with. Figure 1.1 shows the most common ultrasonic devices used nowadays in analytical applications. Not all devices perform equally and neither are all intended for the same applications. Therefore, the first thing to acquire when developing analytical chemistry with the aid of ultrasonication is a knowledge of the differences among the ultrasonic apparatus available, especially of the advantages and disadvantages expected for each one. Therefore, this chapter explains the state-of-the-art of ultrasonic technology as applied to analytical chemistry.

1.2
Cavitation

Sound, including ultrasound, is transmitted through any physical medium by waves that compress and stretch the molecular spacing of the medium through which it passes. As the ultrasound cross the medium (Figure 1.2) the average distance between the molecules will vary as they oscillate about their mean position. When the negative pressure caused for an ultrasonic wave crossing a liquid is large enough, the distance between the molecules of the liquid exceeds the minimum molecular distance required to hold the liquid intact, and then the liquid breaks down and voids are created. Those voids are the so-called cavitation bubbles [1–3].