JACS
JOURNAL OF THE AMERICAN CHEMICAL SOCIETY

BOOK REVIEW

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Review of Microwave Heating as a Tool for Sustainable Chemistry

Microwave Heating as a Tool for Sustainable Chemistry. Edited by Nicholas E. Leadbeater (University of Connecticut, Storrs). From the series: Sustainability: Contributions through Science and Technology. Edited by Michael C. Cann. CRC Press (an imprint of Taylor & Francis Group): Boca Raton, FL. 2010. xii + 278pp. $149.95. ISBN 978-1-4398-1269-3.

Kitchen microwave ovens have been commercialized for more than half a century, but microwave reactors designed for chemical synthesis have a much shorter history. Although they were introduced a decade ago, they have become an important piece of laboratory equipment and have generated a large body of publications. A search on the ISI Web of Knowledge database for "microwave synthesis" returned 13 000 hits, including over 50 review articles and half a dozen book titles. This book focuses on using microwave heating as a sustainable tool for organic, inorganic, and polymer synthesis; medicinal, process, and material chemistry; and bioscience and chemical education. This nine-chapter book edited by Leadbeater with nine contributing authors provides comprehensive coverage on state-of-the-art techniques in microwave heating.

Chapter 1 is an introduction to the principles of microwave heating and commercially available apparatuses. An important topic in this chapter is the "microwave effect", in which the existence of the "non-thermal microwave effect" and a technique called "simultaneously cooling while heating" are discussed. Extremely fast microwave heating could result in inaccurate temperature measurements, and a growing body of evidence indicates that microwave heating is just heating, with no magic involved. More information on the "microwave effect" can be found in a book by Kappe and Stadler.

Chapters 2 and 3 cover organic and polymer syntheses. Most of the sections in these chapters are arranged based on reaction solvents. Protocols for green chemistry, including reactions in water, ionic liquids, and supercritical CO_2, as well as under solvent-free conditions and using ultralow amounts of metal catalysts, are highlighted. Other green chemistry practices such as using alternative feedstock, making degradable polymers, and polymer recycling are also described.

The next two chapters are dedicated to drug discovery and process chemistry. Multicomponent reactions, domino reactions, and solid-supported reactions are highlighted in Chapter 4, although the authors did not draw a clear line between the multicomponent and domino reactions. For example, Schemes 4.5a and 4.8 show two similar reactions but are presented in different sections. Important topics in medicinal chemistry, such as hit-to-lead optimization, structure- and knowledge-based design, phenotypic drug discovery, and DNA-based technology, are mentioned in Chapter 4, but with little detailed information. On the other hand, Chapter 5 on process chemistry is much more informative and comprehensive. It has many figures and schemes to show the scale-up microwave equipment and provides many examples. Readers should pay attention to Section 5.7 on the energy efficiency of microwave heating because different results on the comparison of microwave heating versus other heating sources have been reported in literature. Microwave heating has to be evaluated on a case-by-case basis; it is not always more energy efficient.

Chapter 6 presents successful stories of introducing microwave heating to the undergraduate laboratories at Merrimack College. Most examples highlighted in this chapter are related to organic chemistry. Analytical, inorganic, and material chemistry are briefly mentioned. This chapter may not be of interest to research scientists, but it could be useful for those involved in undergraduate chemical education.

Microwave heating for applications in organometallic chemistry, materials science, and bioscience are described in Chapters 7−9. These special areas generally have not been well documented in other books. Organometallic chemistry using kitchen microwave ovens is presented in several sections of Chapter 7. Authors should be advised that chemical research using kitchen microwaves is no longer an acceptable practice from the standpoints of both safety and experimental reproducibility. If anyone wants to repeat a kitchen microwave reaction, it should be done using a multimode microwave reactor instead. Microwave-assisted synthesis of adsorbents, battery materials, ceramics, zeolite materials, and metal organic frameworks (MOFs) are showcased in Chapter 8. Microwave techniques for bioscience are described in the last chapter of this book, which features the synthesis of peptides and preparation of proteomics samples.

Microwave heating is a maturing technique and continuously finds new applications. The chapters in this book cover broad topics and are loosely connected by the theme of sustainable chemistry, although many chapters should have included more experimental results. This book is a useful complement to literature reviews and other books on the topic. For those who are interested in green and sustainable chemistry, it is well worth reading.

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10.1021/ja201010u

Published: February 09, 2011