Chemistry in Motion

The challenge inherent in writing an interdisciplinary text such as *Chemistry in Motion* is that it must both be accessible to audiences from varied backgrounds and also cover its topic in sufficient depth to prove its worth. *Chemistry in Motion* succeeds in both these areas as it tackles the ubiquitous, yet often overlooked topic of chemical reactions which occur in non-equilibrium, diffusing systems. In particular, this text explores the physics and simple experimental conditions that lead to the spontaneous generation of chemical waves and how these concepts can be employed to fabricate complex microstructures.

The book is written as an extended tutorial review of the reaction-diffusion field and is geared toward a diverse target audience of chemical engineers, physical chemists, and materials scientists. It begins by briefly discussing the different biological systems which incorporate diffusion-mediated reactions. It then delves into the mathematical framework that gives rise to these phenomena, before returning to a more generalized, applications-oriented discussion. These applications include the fabrication of three-dimensional and/or periodic structures by lithography, chemical sensing, and amplification applications, and the synthesis of particles with controlled geometry within gels.

While the mathematical discussion which comprises the first few chapters of this book is well written and is laid out in a logical fashion, even the book's author admits that this section of the text is not a light read. The section begins with a discussion of Fick's laws, and quickly progresses into various analytical and numerical methods for solving three-dimensional diffusion equations. The solutions to these equations are then related to complex real-world chemical systems by incorporating the rate constants of the various reactions, culminating with a discussion of how the physics of reaction-diffusion interfaces with the complex kinetics of oscillatory chemical reactions. While a cursory understanding of the physics involved may have been a necessary prerequisite to fully appreciate the remainder of the text, one cannot help but think that this rigorous mathematical treatment may have been better served much later in the text, once the audience has become more invested in the subject matter.

As presented, the mathematical section lies in stark contrast to the rest of the text, which is a good lunch-table companion, filled with eye-catching colored images of the remarkable tessellated structures easily created with reaction-diffusion experiments. These images entice the perspective reader in with their simple, yet beautiful structures—so much so, it seems, that the book rarely remains where one left it for any appreciable period of time. Every passerby with an enquiring mind is guaranteed to pick up this book and flip through its pages, curious to learn the science behind the art.

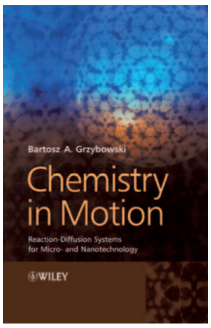
As the first studies of reaction-diffusion systems were performed as far back as the late 1800s, the field is relatively mature. The recent research reviewed in this text, therefore, focuses on miniaturizing these systems and increasing their complexity in order to widen their applicability, especially with respect to microfluidics and particle synthesis. Several useful, three-dimensional, microscopic structures are presented which can be formed simply by a wet-stamping procedure which takes advantage of the physics inherent in reaction-diffusion systems. A corollary avenue of research explored in the text is the increasing use of computational modeling, which has facilitated the design of these increasingly complex systems.

Although this text shows that a rich variety of complex structures can be made with reaction-diffusion systems, this complexity is a double-edged sword for the field. Small perturbations in the initial conditions of the systems create vastly different results. Moreover, due to the inherent stochastic nature of diffusion, extensive modeling and simulations are often required to deduce the initial conditions necessary to create each new pattern. Meanwhile, the traditional synthetic techniques that compete with reaction-diffusion-type syntheses (lithography, chemical etching, CVD, etc.), while more time-consuming to perform, are in general much more intuitive and have gentler learning curves. Thus the eager scientist must decide which he or she wishes to spend the bulk of their time on: *planning* a synthesis which can ultimately be carried out quickly and repeatedly, which takes advantage of reaction-diffusion physics, or *performing* a synthesis whose numerous steps are time-consuming, yet obvious. Accordingly, the impetus for growth in this field may come from industry, where the focus is on minimizing processing steps and maximizing throughput.

In summary, this text can be viewed as a first stepping stone into the reaction-diffusion field. It is a quick, informative survey of what types of syntheses are possible in reaction-diffusion systems; it provides the necessary framework to begin an in-depth project in the field; and most importantly, it is an enjoyable read.

Michael Ibele
Department of Chemistry
Pennsylvania State University (USA)

DOI: 10.1002/anie.201005949



Chemistry in Motion
Reaction-Diffusion Systems for Micro- and Nanotechnology. By Bartosz A. Grzybowski. John Wiley & Sons, Hoboken 2009. 302 pp., hardcover € 119.00.—ISBN 978-0470030431