Book Reviews *

Ultrafast Infrared and Raman Spectroscopy. Practical Spectroscopy Series Volume 26. Edited by M. D. Fayer (Stanford University). Dekker: New York, Basel. 2001. xii + 710 pp. $195.00. ISBN 0-8247-0451-7

This volume consists of 16 chapters that address various experimental and theoretical aspects of modern ultrafast time-resolved vibrational (infrared and Raman) spectroscopy. The authors are a cross section of the current leaders in this field, and together they present a good overview of the status of the field at this time. The book's emphasis is almost entirely on condensed phase vibrational dynamics, where these techniques find their main use. The molecular systems discussed range from diatomic molecules and ions in liquids to ionic solids, with three chapters emphasizing biophysical systems. Many of the chapters are entirely or largely concerned with the physical process of vibrational energy relaxation: i.e., through what pathways and on what time scales does a particular vibration of a molecule, excited at some instant in time, lose that excess energy to other vibrations of the molecule and/or the surrounding environment? Other phenomena discussed are vibrational dephasing, intramolecular anharmonic coupling, intermolecular forces, and chemical reactions involving bond formation or bond breaking.

Four of the chapters are purely theoretical in scope, whereas the other twelve are fundamentally experimental but include, in some cases, rather detailed discussions of the theory and modeling needed to interpret the experiments. The chapter by Piryatinski, Chernyak, and Mukamel on two-dimensional spectroscopy of peptides and proteins gives a detailed description of a specific experimental configuration, discusses what the data should look like for given material parameters, and interprets some existing experimental data, partially overlapping the analysis of the same data presented by Hamm and Hochstrasser in another chapter. The other three theoretical chapters (Skinner, Egorov, and Everitt; Hynes and Rey; and Stratt) focus more on the fundamental physics of the relaxation processes that come into play in many different experiments discussed in various chapters. Among the experimental chapters, some focus mainly on the technical aspects of particular experimental configurations (Heilweil on broadband transient IR spectroscopy; Berg on Raman echoes; Blank et al. on two-dimensional fifth-order Raman spectroscopy; Iwaki et al. on IR pump/Raman probe measurements; Koehl, Crimmings, and Nelson on impulsive stimulated scattering in crystalline solids), some go into much more detail on what has been learned by studying a small set of specific molecular systems with these techniques (Yang and Harris on bond activation reactions of organometallic compounds; and Myers et al. on vibrational relaxation in supercritical fluids), and still others contain a roughly equal mixture of both (Laubereau and Laenen on ultrafast CARS and IR spectroscopy of liquids; Rector and Fayer on IR echo decays and spectroscopy; and Fourkas on nonresonant intermolecular spectroscopy of liquids). The two experimental chapters on biological systems present, in a sense, two extremes of modern biophysical spectroscopy. Lim, Jackson, and Anfinrud have taken the rather straightforward technique of visible pump/IR probe spectroscopy and pushed it to very high precision to answer a number of long-standing questions about ligand dynamics in heme proteins, one of the earliest problems to be studied by time-resolved vibrational techniques. Hamm and Hochstrasser, on the other hand, describe the development and application of a new technique, two-dimensional IR spectroscopy, to look at the vibrational couplings in peptides.

A few topics that would seem appropriate for such a compilation are missing entirely: vibrational dynamics at surfaces and interfaces, ultrafast terahertz techniques, and coherent control of nuclear motions. Nevertheless, the book's scope is quite broad, and every chapter makes a valuable contribution. The chapters vary considerably in length, some being much more ambitious than others in terms of the amount of material covered, but in all cases one gets the feeling that the authors have been allowed enough length to fully develop their topics as they define them. Some of the writing is truly excellent. In particular, the rather short final chapter by Skinner, Egorov, and Everitt on vibrational energy relaxation in liquids and supercritical fluids is a model of precision and clarity in dealing with a few rather narrowly defined problems. The chapter by Hynes and Rey on small molecules in polar solvents is notable for lively, interesting, and occasionally humorous use of language and sometimes unexpected yet entirely appropriate word choices. The chapter by Fourkas begins with a marvelously pedagogical general introduction to vibrational spectroscopy before specializing to the topic of intermolecular vibrations in liquids, which is also presented very lucidly. The first 20 pages of this chapter should be tremendously helpful to new graduate students starting out in any area of vibrational spectroscopy.

The book looks good to the eye. It is well designed and attractively presented. The pages are laid out clearly and legibly, with wide margins and plenty of space around equations and figures, the equations are typeset cleanly and legibly, and in general the book is very readable. With the exception of one chapter, most of the graphical material is of high quality and large enough to be read easily. The index, often very cursory and inconsistent in edited books such as this, is reasonably good here. The chapters all seem to be about as well up-to-date as can be expected; most cite at least some literature published in 1999, and some include papers from 2000. A minor stylistic inconsistency is the inclusion of reference titles in some chapters but not in others. While most of the contributing authors appear to be surprisingly good writers, there are a few exceptions, and a few of the chapters would have benefitted from more thorough editing and/or proofreading for typographical and/or grammatical errors.

A compilation of this type, while quite comprehensive, is really not cohesive enough to work very well as a textbook. Even if it were, few institutions have the luxury of offering even a special topics graduate course on such a specialized subject. The book is, however, an excellent summary of the current state of the art for anyone from a graduate student or postdoctoral fellow to a faculty member entering the field, and a useful reference for those currently in the field. I learned a great deal from reading this book and I am sure that I, and the members of my group, will refer to it frequently for some time to come. Although the buyer does get a lot for the money, the $195 price tag will be a significant deterrent to widespread individual ownership of the book. I imagine the majority of purchasers will be libraries in institutions that have faculty working in this or related fields.

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Oxidative Delignification Chemistry: Fundamentals and Catalysis. Edited by Dimitris S. Argyropoulos (McGill University). American Chemical Society (Distributed by Oxford University Press): Washington, DC. 2001. x + 534 pp. $175.00. ISBN 0-8412-3738-7.

This book emerged from a symposium held in March 2000 in San Francisco, CA, on the topic of oxidative delignification chemistry. It offers a comprehensive review of oxidative alternatives to chlorine-based pulp-bleaching practices. The chapters are organized under the following three sections: Fundamentals of Oxygen-Peroxide Delignification Processes; Biomimetic Systems; and Oxidative Enzymes.

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