PREFACE

It has been a little over half a century since the first direct observation of the synchrotron light at the research laboratory of the General Electric Company in Schenectady, New York. From that humble beginning, synchrotron radiation research struggled through infancy in the sixties, gained significant growth in the seventies and eighties, and has now evolved to become arguably the most powerful technology to probe the behavior of electrons and its implications to the properties of matter. Today, the so-called third generation synchrotron radiation sources are perhaps the most desirable tunable-light technology for a wide variety of applications, from infrared to X-rays. These new sources are based on low emittance (small electron beam size) and the use of insertion devices (alternating magnetic fields installed in the straight section of the electron storage ring). The insertion devices force the electron to undergo many controlled mini bends (wiggling), resulting in a source that can be partially coherent and polarization-adjustable. These devices provide tunable photons with unprecedented brightness and versatility. The small beams thus generated have permitted new scientific discoveries and advancement in technology, most noticeably in the areas using microbeams. These third generation sources had just begun making significant contributions in the last several years and are becoming widely accessible around the world.

Chemical applications of synchrotron radiation have always been a very important part of the development of synchrotron radiation science and technology. Despite the importance, there have been very few monographs dedicated to the topic. In addition, as in the development of many technologies, when the techniques evolve and become more matured, there is a time to introduce them to the research community at large. This monograph was conceived with the belief that the time had come to put together a monograph to describe recent advancements in a wide range of chemical applications using synchrotron radiation.

In this monograph, there are twenty-six chapters organized in two parts. All are invited contributions from researchers in the forefront of their field. It is perhaps not surprising that many topics are intimately related to the traditional disciplines of chemistry such as gas phase photoionization dynamics and spectroscopy, surface chemistry, materials, diffraction and scattering, chemical microscopy and radiation chemistry. Despite the large number of topics, the list is by no means exhaustive. Noticeably missing are topics of specific interest to bioresearch such as macromolecule crystallography, and chemical crystallography. Although most of the topics have a chemical favor, the techniques described here are undoubtedly applicable in many other areas of research such as atomic, molecular and condensed matter physics, bioscience, material's science, earth science and environmental science.

The Part I of this book, Dynamics and VUV Spectroscopy, contains twelve chapters. It focuses on the use of the low energy spectrum of synchrotron radiation (IR, UV and VUV). The first four chapters deal with the absorption and de-excitation dynamics of molecules in the gas phase. The use of a third generation synchrotron source has permitted the studies of reaction dynamics in some details (Suits). The studies of the nature of the super excited state and the associated decay channels have enabled detailed understanding of the dynamics using a variety of yields and coincidence techniques (Hatano; Poliakoff; Hitchcock and Neville). The polarization dependence of the absorption process has offered new insight into the electronic structure of matter (Kosugi). Chemically sensitive imaging using IR and VUV radiation has also been explored (Ade and Urquhart; Dumas and Williams) and these techniques are now generally known as spectromicroscopy.

The synchrotron study of a special group of materials, the functional organic materials (Seki, Ishii and Ouchi), can be found in Chapter 8. The photodissociation dynamics of surfaces as compared to their gas phase counter parts has been explored (Rosenberg and Frigo) and so has the dispersive fluorescence following core hole excitation (Nordgren, Butorin, Duda, Guo and Rubensson). Spectroscopic studies of chemically modified surfaces (Hrbek) and electronic and magnetic materials (Himpsel) reflect the theme of spectroscopic studies of materials in Part I.

The Part II of this book, X-ray Applications, contains fourteen chapters and all deal with the applications of soft and hard X-rays in either absorption or scattering. The first two chapters describe the general principles (Lagarde, Frank) and the surface applications of soft X-ray spectroscopy (Ohta) followed by special applications in X-ray Excited Optical Luminescence (Rogalev and Goulon) and reflectivity (Heald and Jiang).

X-ray scattering and diffraction are the themes of the following four chapters. Topics include small angle scattering (Chu and Hsiao), inelastic X-ray scattering using very high energy X-rays (Hayashi, Udagawa, Gillet, Caliebe and Kao), powder diffraction (Tse) and time-resolved, spatially-resolved X-ray diffraction studies of reactions (Wong). An often ignored, but very important subject, radiation chemistry of liquids using synchrotron radiation can be found in the subsequent chapter (Holroyd and Preses) where the implication of radiation chemistry of liquids to conductivity XAFS was discussed in some details. What follows are three interesting technology chapters in microprobe applications, especially in environmental samples (Jones and Feng), photochemical and photoetching processes (Urisu) and tribology (Suominen, Fuller, Kasrai and Bancroft).

The application of a multicore, multidetection channel technique in the X-ray absorption studies of thin films is discussed in Chapter 25 (Sham, Naftel and Coulthard) where it was shown that the use of soft X-rays to probe several core levels together with the use of different yields (electron, fluorescence photon and optical photon) provides some chemical and sampling depth selectivity.

The final chapter discusses the recent status of the theory of perhaps the most widely used technique in chemical applications of synchrotron radiation, the XAFS.

It has been an enlightening experience and a lengthy process to put together this monograph. I would like to thank all the authors for their contributions. Without their enthusiasm, understanding and patience, this project could not have been completed. I also like to thank many of my colleagues and members of my research group for their various assistance, Professor Cheuk Yiu Ng, the series editor, for the suggestion of the project and his encouragement and understanding throughout the process, and World Scientific, the publisher, for providing high quality service to the

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