Foreword

Radiation chemistry, which probes the changes induced in a medium upon absorption of energy, is a mature discipline. Its origins lie in the discovery of ionizing radiations from naturally occurring isotopes in the late 19th Century. It was thrust to importance following the unleashing of atomic energy within the Manhattan Project; the laboratory where I write was founded by Milton Burton at that time. Subsequent advances in instrumentation and techniques for both excitation and detection have provided insight into the detailed nature of the interactions of the deposited radiation within the medium and allowed quantification of the ensuing physical and chemical transformations.

In *Recent Trends in Radiation Chemistry*, *Wishart* and *Rao* have assembled contributions from a number of well-known investigators in the field documenting its growth, highlighting its present-day significance, and offering potential opportunities for its future course.

A historical perspective on these developments is given in the first chapter by *Jonah. Janata* offers a detailed account of the key technique of electron pulse radiolysis, then firmly placed on the modern stage of ultrafast techniques in the chapter by *Belloni et al.* By far the most common detection scheme is that of transient optical absorption, however chapters by *Warman* and *de Haas* (on microwave conductivity) and *Le Caër et al.* (on infrared spectroscopy) illustrate alternative approaches. Others, not explicitly addressed, but key to the identification of transients, include time-resolved resonance Raman and electron paramagnetic resonance spectroscopies to which Tripathi, Schuler and Fessenden from this laboratory, have made signal contributions.

Simply because it is so easily detected, the solvated electron has played and continues to play a central role in the development of the field. *Mostafavi* and *Lampre* provide a fascinating overview of some of the extensive experimental work on this species covering both formation (localization and solvation) and decay (reactivity). Recent theoretical attempts to address its structure and dynamics are reviewed by *Shkrob*, who leaves the reader with a list of significant challenges which must be overcome before a satisfactory understanding of this species can be achieved. We note that even in the most ubiquitous medium, i.e., water, the hydrated electron has not yet, to the best of my knowledge, been accorded a registry number by the Chemical Abstract Service of the American Chemical Society. While the reductive arm of radiolytic decomposition has been extensively investigated and the evolution of the electron spectrum well characterized from early times, much less is known about the initial fundamental processes in the complementary oxidative channels which must also be present.

The radiation chemical yields induced by energetic "heavy ions", protons, alpha particles and more massive accelerated charged nuclei are significantly different from those due to fast electrons and high-energy photons. Much of the early theoretical work seeking an explanation of these differences is collected in the book of Mozumder on *Fundamentals of Radiation Chemistry*. Key features of the observed track structure of these particles have led to their increasing deployment in radiation therapies. Recent developments and exciting new directions in heavy-ion radiolysis, particularly the introduction of short-time pulse methods, are discussed by *Baldacchino* and *Katsumura*.

It might be expected that after years of study, the radiation chemistry of liquid water and dilute aqueous solutions would have been thoroughly documented. However, many modern day applications take place under conditions far from ambient. In particular, in nuclear reactors, temperatures and pressures are such that criticality is approached. Indeed future coolants have been proposed in the supercritical regime. *Lin et al.* describe the challenges in obtaining reliable quantification of the processes occurring in sub- and super-critical water and document some of the unusual temperature and pressure dependencies observed in the reaction rates of even fundamental radical species. Other industrial applications in chemical synthesis, extraction, separation processes, and surface cleaning also use supercritical fluids. *Holroyd* reports results from fundamental studies on electron and ion processes in supercritical rare gases in Chapter 10 with an aim to improving the utility of such media.

In real-world applications, the importance of interfaces is hard to overestimate and three chapters are devoted to the effects of radiation at aqueous–solid boundaries. *Jonsson* focuses on applications within the nuclear industry where basic studies on radiation effects at water–metal interfaces have enabled a proposal for safe storage of spent nuclear fuel. Also with implications for the nuclear industry, *Musat et al.* document alterations in the radiation chemistry of liquid water confined on the nanoscale. Such nanoconfined solutions are prevalent in the media proposed and indeed in use for waste storage. In another application, radiation chemistry has successfully been used to produce nanoscale objects such as metallic clusters and nanoparticles, an area summarized by *Remita* and *Remita*.

Fundamental studies on the radiolytic oxidation of aromatics (*Rao*) and radiolytic redox reactions as seen in electron transfers (*Brede* and *Naumov*) are reviewed in Chapters 14 and 15.

The last five chapters illustrate the importance of radiation chemical techniques in building an understanding of biochemical and biological response to the impact of ionizing radiation. *Bobrowski* thoroughly reviews the many aspects of the one-electron oxidation of sulfur-containing species in biosystems. *Cabelli* describes the interaction of radiolytically-generated radicals with amino acids and proteins, while *Priyadarsini* summarizes many of the cellular repair processes involving antioxidants which exist to mitigate such damage to key biomolecules. Radiation damage to that most-important molecular constituent of the cell, DNA, is described in two chapters. *Becker et al.*

discuss direct effects where the consequences of ionization of DNA itself are considered. The interaction of radicals generated by radiolysis of the surrounding medium, such as the electron and hydroxyl, with DNA and its components is the topic of *von Sonntag*.

Recent Trends presents a picture of radiation chemistry as a vibrant field of international venue, still addressing fundamental challenges as it continues to grow into its second century. This image is reinforced, and both broadened and deepened, by a number of edited volumes: *Radiation Chemistry: Present Status and Future Trends* — Jonah and Rao (2001); *Charged Particle and Photon Interactions with Matter* — Mozumder and Hatano (2004); *Radiation Chemistry: From Basics to Applications in Material and Life Sciences* — Belloni *et al.* (2008); which have appeared within the last few years. A clear articulation of prospects for future development was also presented at the recent visionary meeting "Radiation Chemistry in the 21st Century" held at Notre Dame in July, 2009.

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