Preface

Radiation chemistry has witnessed an entire gamut of exciting events since its discovery more than a century ago, contributing not only to chemistry but to other branches of science encompassing simple to complex molecules. Today, ionising radiation and its effects are playing a crucial role in a number of technologies such as power generation, advanced materials, the nuclear fuel cycle, radiation therapy, sterilization, and pollution prevention and remediation. The free radical mechanisms of biomolecules relevant to health and medicine, including DNA, are crucial for understanding the origins and treatment of many diseases. Heavy ion radiolysis remains a vital interest of radiation chemists, for example in the areas of fundamental radiolytic processes, nanosynthesis using track structure, highly site-specific radiation therapy, and the effects of heavy ion radiation on astronauts and materials during prolonged space flight.

In this book, we have made an effort to provide an overall view of the emerging trends in radiation chemistry authored by experts in the field. The introductory chapter covers the history of radiation chemistry, underlining its achievements and issues that need to be addressed in future research. By renewing its research directions and capabilities in recent years, radiation chemistry research is poised to thrive because of its critical importance to today's upcoming technologies. Detailed accounts of fast and ultrafast pulse radiolysis instrumentation development and recent advances on ultrafast

dynamics of solvated electrons enabled by the latter form the basis of the chapters immediately following.

In the next two chapters, the coupling of time-resolved microwave conductivity and infrared spectroscopy techniques to pulse radiolysis is discussed. The following review highlights the progress made on water radiolysis with heavy ion beams. The subsequent chapters on the radiolysis of supercritical water, radiation-induced processes at solid–liquid interfaces and radiolysis of water-confined nanoporous materials discuss the essential features that are relevant in the development of new generations of nuclear reactors and waste management. The article on supercritical xenon and krypton fluids focuses on the properties and reactions of charged species, electrons and ions, providing useful information for their utilization in particle detector and industrial applications.

Nanoparticles are rapidly gaining popularity in biomedical, optical and electronic areas. Zapping tumors with multi-walled carbon nanotubes, solar cells to light-attenuators and chip-to-chip optical interconnects in futuristic circuitry are some of the potential applications. Thus finding novel ways for the synthesis of these new age materials is of paramount interest where radiation chemistry is modestly playing a role and the chapter on metal clusters and nanomaterials deals with these aspects.

The fundamental aspects of structure–reactivity relationships in radiation-induced oxidation of substituted benzenes, bimolecular free electron transfer on the femtosecond time scale, the chemistry of sulfur-centered radicals and the radiolysis of metalloproteins are discussed in succeeding chapters. The effects of the direct and indirect mechanisms of radiation-induced DNA damage are discussed individually in two complementary chapters. The last chapter highlights the application of radiation chemical techniques to antioxidant research.

The purpose of the book is to expose graduate students and young scientists working in the field to recent developments in radiation chemistry research and to demonstrate to scientists, engineers and other technologists the utility of radiation chemical techniques in advancing their scientific pursuits. The fact that radiation chemistry is

a vital part of molecular science is more than evident from the diverse topics found within these covers.

The road to completion of this book was long, and we sincerely appreciate the cooperation and understanding of all the individual authors and thank them for their tremendous efforts to painstakingly prepare their chapters to meet the education and outreach goals described above. We enjoyed the job of editing and many people have helped us in this task. We would particularly like to thank Ms. Sook Cheng Lim and Ms. Ling Xiao at World Scientific Publishing who helped us in the planning and execution of the project. Our special thanks go to Ms. Parimal Gaikwad at the University of Pune for doing an excellent job of preparing the near camera-ready copies of the entire book. BSMR thanks the DAE-BRNS for the award of the Raja Ramanna Fellowship enabling the completion of the project. JFW thanks the U.S. DOE for support under contract DE-AC02-98CH10886. Lastly, we would like to thank our wives for their patience and understanding which made our task easier.

James F. Wishart and B. S. M. Rao