Preface

The diversity of Liquid Crystals is evident in everyday life in incarnations ranging from liquid-crystal displays to biological membranes. It is therefore important to have a good understanding of these materials to further the progress in this field of research and development. To achieve this, no single technique, whether it is theory or experiment, can provide a clear understanding of the fundamental physics and chemistry of liquid crystals. There is no doubt that the liquid-crystal field is interdisciplinary in nature and requires the expertise of biologists, chemists, physicists, engineers and materials scientists. Indeed it also provides a ground for cross-fertilization of different research areas to achieve new potential applications in the fields of telecommunication, medicine, memory devices and beyond. Nuclear magnetic resonance is one of the experimental techniques that were used early on (in the early nineteen sixties) to unravel and harness the intrinsic anisotropic potential that exists in these materials. Given the number of NMR active nuclei, the wealth of modern NMR pulse techniques and the technical advances in NMR instrumentation, the happy marriage between NMR and liquid crystals is clearly demonstrated in this volume. The Editor has written a text that bears the same name as this volume some sixteen years ago; he mentioned then the limitation of a single-author book is necessarily hampered by the limited research interests of the writer. However, the main aim was to lay down the theoretical NMR and liquid-crystal physics background for the benefit of newcomers to the fields of NMR and Liquid Crystals. An indication of the success of that aim is that the text is being used by many graduate students and other researchers. The present edited volume certainly covers more diverse applications of NMR in liquid crystals, and it is hoped that this can serve as a compendium to the earlier text.

The volume contains the latest state-of-the-art developments in using NMR to study liquid crystals. Small solutes (as well as not so small proteins) in thermotropic and lyotropic liquid-crystal phases are discussed in

Chapters 1 to 4. These chapters are mainly focused on observed spectroscopic (equilibrium) properties. These are followed by chapters on the liquid-crystal molecules using deuterium, proton or carbon-13 nuclei in these molecules as probes to sense dynamical properties and/or static properties like the orientational ordering and phase structure. The question of quenched disorder of a liquid crystal confined in silica aerosol gel networks is studied in Chapter 7 by using deuterium probes located within the liquid crystal via chemical deuteriation. Chapters 5 and 8 deal with proton and deuterium spin relaxation, respectively, of numerous different liquid-crystalline phases formed by molecules of increasingly complex anisometric shapes. Chapter 6 deals with deuterium NMR of chiral tilted phases and the effect of the NMR field. Chapter 9 describes a proton study of self-diffusion of liquid-crystal molecules by utilizing the large fringe field gradient in a superconducting magnet. Chapter 10 describes a means of combining the external electric field and the NMR field to probe the director reorientational dynamics in a deuterated nematic liquid crystal. The director dynamics and individual molecular motions (translation or reorientation) are closely tied to the elastic and viscous properties of liquid crystals. Chapter 11 provides a survey of theoretical approaches to treat viscoelastic properties of liquid crystals and to give possible relations between theoretical predictions and NMR observables. The remaining two chapters have to do with carbon-13 NMR of calamitic liquid crystals. The former one deals with the study of orientational order parameters, and molecular conformation in rod-like and bent-core mesogens. The latter one provides a combined density functional theory and NMR study of a specific bent-core liquid-crystal molecule that is known to exhibit in bulk a uniaxial and a biaxial nematic phase upon decreasing temperature.

The scope of this volume is necessarily limited by its size and the expertise of the contributors. However, it is our hope that it can provide a glimpse of the latest news in the field of Liquid Crystals, in particular what NMR can offer to advance the understanding of the underlying principles in this type of soft matter. The Editor is most grateful to all the contributors (and friends) to make his dream come true. He is also indebted to his wife Natalia for putting up with him days and nights as well as weekends on this book project.

Ronald Y. Dong
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