Preface from the Editors

Nuclear Magnetic Resonance, NMR, is now about 60 years of age. Over the years it has been declared dead surprisingly often, using the arguments that everything has been described theoretically, that all basic experiments had been done and that technological development would increase the power of NMR only marginally, at best. Most of these predictions have turned out to be so entirely wrong that the skeptics have now given up.

However, a certain discrepancy remains in the way NMR is understood, which can be explained by the various points of view that are assumed by different people. The year 1945 did not merely represent the birth of a new method for understanding the properties of matter; nor did it see the birth of an entirely new branch of science, although some may prefer to view it that way. Although NMR is based on fundamental aspects of physics and chemistry, the principles of which were mostly understood and described in seminal works during the first two decades of the lifetime of NMR, during this time, NMR has developed a whole toolbox of methods that can deal with almost any question arising in the context of structure and the dynamics of matter.

Of the many areas where NMR is applied these days, two can be considered as being established. The most important is certainly its use for structure elucidation, from small molecules up to medium-sized proteins in solution; no university with an analytical lab can afford to be without a liquid-state, high-resolution NMR system. Most chemistry students will come into contact with NMR at least once during their courses. Second, is diagnostic medical imaging, which many of us may have experienced personally. From the first crude and blurred NMR images that were acquired over 30 years ago, incredible developments have been achieved by the efforts of researchers and industry alike.

With all this progress taking place, it is somewhat surprising that the commercially important sector of industrial production, synthesis and quality control has only taken notice of NMR relatively recently. When we were collecting information and literature during the early stages of the preparation of this book, we realized that NMR spectroscopy has indeed gained widespread acceptance for analysis purposes, although this is still not usually on-line or in-line. However, the potential, from a scientific and more significantly also from an economic point of view,
of MR imaging in the various fields of Chemical Engineering is vastly under-exploited. After over a decade of systematic research in non-medical fields of transport phenomena by NMR, both hardware and measurement techniques and data interpretations have become sufficiently robust to enable routine applications to be made in the near future, so a compilation of current trends and case studies appeared absolutely necessary. Collating and combining this information from different sources seemed particularly appropriate to us, as there are no books, periodicals nor conferences which treat this rapidly expanding field in a dedicated manner.

As a result of all these considerations, we decided to include only those works that employ NMR imaging methods (in the wider sense, i.e., pulsed field gradient NMR) in a fashion that is not yet established, i.e., utilizing novel NMR methods and techniques, or demonstrating its great potential for applications that have not been routinely explored by NMR imaging. This is why only a few contributions are presented from the well established branch of pulsed field gradient NMR for porous media studies, utilizing diffusion for materials characterization. Even with this limitation, there remains a wide range of applications by so many great scientists that can not be included in one book. We have tried to present a variety of work with the purpose of giving a flavor of what we regard as state-of-the-art of non-medical NMR imaging. This book does not aim to highlight who is leading the field in non-medical NMR imaging, but rather intends to convince many scientists and chemical engineers how “cool” NMR imaging is and that it is worth looking into.

Hopefully the reader will benefit from this manifold approach, which casts light on the topic from a range of perspectives. Many of the contributors were originally physicists or chemists who became curious about particular applications, while an increasing minority of workers are contributing expertise from a Chemical Engineering aspect and introducing questions that are completely new to the fundamental researcher.

We considered the possibility that the audience of this book will probably share the same varied backgrounds as its authors. Even more generally, we want to reach researchers in academia and industry alike. For the academic sector, it is mainly postgraduate students but also faculty members who are addressed, all of whom are willing to gain an overview of existing techniques, limitations and strategies to solve individual problems from an engineering perspective. From many discussions with engineers we concluded that such an overview and a demonstration of the feasibility of the methods were desired. For the academic NMR researcher, who is often restricted to model systems and might lack insight into “real” problems, the various examples in the book provide a link to applications. Industrial researchers, or decision makers, will gain a sufficiently detailed view of the NMR toolbox, which can enable them to estimate the applicability of NMR to their particular problems, with respect to, for example, cost efficiency and output interpretability, and provides them with contact points to obtain further information. The Introduction and the various chapters are written in such a way that together they can help the reader understand the essential results without any prior knowledge of NMR.
Finally, we must confess that compiling this book was great fun. For once, we could collect together excellent pieces of work in this field without being jealous that we haven’t done the particular work ourselves! We are most grateful to all contributing authors who shared our point of view that a demonstration of the power and, in addition, the beauty, of NMR imaging is the best way to spread the news that it is an exceptionally versatile tool. This book is about applications; it tells the reader what is possible, and how to solve a particular problem that he or she has encountered in the lab or the factory. It does not give a final recipe to the reader, but provides him with a lot of the necessary ingredients to allow him to find the best solution. If the book succeeds in doing this and makes the reader familiar with a technique or an application he or she hasn’t thought of before, then the goal has been achieved.

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