

Preface

Nuclear magnetic resonance (NMR) spectroscopy is arguably one of the most potent experimental techniques for probing molecular structure at ultra-high resolution both in liquids and solids. Despite its pivotal role in chemical analysis both in biological and non-biological contexts, the technique itself suffers inherently from low sensitivity, owing to the extremely small energy separation existing between nuclear spin states in the presence of the static magnetic field of an NMR spectrometer. Thus, a range of different measures aimed at increasing nuclear polarization has been established ever since the introduction of NMR as an analytical technique, including, among others, the use of sensitivity-enhancing pulse sequences, higher magnetic fields, cryogenically cooled probes, and particularly in the context of the present contribution, the application of methods to increase nuclear sensitivity in a chemical or physical manner. In particular, the latter approach has yielded highly satisfactory results, making it an extremely attractive alternative to some of the more costly setup modifications described before.

Here, key players working in the area of nuclear hyperpolarization methods in NMR spectroscopy have gathered to present the state-of-the-art and to report on cutting-edge developments accomplished in the field during the last 10–15 years or so. The selection of contributions highlights, in particular, nuclear hyperpolarization methods based on two chemical, i.e., *para*-Hydrogen Induced Polarization (PHIP) and *photo*-Chemically Induced Dynamic Nuclear Polarization (CIDNP), and a physical phenomenon, i.e., dynamic nuclear polarization (DNP), which can be exploited to perturb nuclear spin state distributions in situ, i.e., inside the NMR spectrometer during an ongoing chemical or physical process. Interestingly, all of these methods have experienced renewed interest in recent years, although their underlying chemical or physical principles have been known for a relatively long time. In addition, continuous efforts to improve methodologically the different techniques have transformed their application from purely a means to increase spectral sensitivity to a valuable tool for addressing problems both in mechanistic organic chemistry and, structural biology. The emerging importance of magnetic resonance imaging/tomography (MRI/T) techniques has fuelled the interest in hyperpolarizing nuclear spins using in situ NMR methods, e.g., DNP or PHIP, even further. Nevertheless, the present collection of texts does not claim to provide

a complete picture of the entire field of nuclear hyperpolarization as this would have surely exceeded the intended boundaries of this book, both in size and scope. For example, the area of hyperpolarized noble gases has, on purpose, been omitted entirely. In principle, this volume of “Topics in Current Chemistry” is believed to be suitable both for scientists working in the field of nuclear hyperpolarization and for researchers expecting to get a first glimpse of the subject. In addition, spectroscopists entirely unfamiliar with the methods presented here might use this collection of texts as a source of thought-provoking impulses to add, if desired, sensitivity-enhancing features to their particular experiments.

Last but not least, I would like to thank sincerely all contributors for their efforts and patience to make this highly stimulating and, in my humble opinion, worthwhile endeavor possible. On a more personal note, deep gratitude is owed to Joe Bargon, a good friend and scientific mentor, who first kindled the editor’s interest in this fascinating area of nuclear magnetic resonance research.

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