Preface

Das erste was die Erfahrung zu tun vorfindet ist uns von den Hirngespinsten und falschen Begriffen zu befreien welche sich in der Jugend angesetzt haben.[1]

Arthur Schopenhauer

This book discusses the basics of contemporary magnetism as encountered in today's familiar applications, such as the magnetic tape on a credit card or the read head in a personal computer. Nevertheless, the discussion is not particularly centered on immediate products, as emphasis is placed on revealing key concepts and magnetic phenomena on which such practical applications rest. Therefore, this book does not have a commercial focus, nor is it meant to provide an up-to-date reference on the latest research accomplishments of the different magnetics subjects. On the contrary, it is up to the reader to uncover the connection between these concepts and everyday life where magnetism reveals itself, and as such continue to explore further. After all, the main goal is to entice people to recognize on their own the myriad of subtle associations developed in time between disparate and seemingly unrelated areas of magnetics. For this reason, it should not come as a surprise when the discussion takes the reader over a variety of combined physical manifestations or different length scales of phenomena, revealing aspects not always immediately recognizable as belonging to magnetism. Moreover, the questions/problems at the end of each chapter are meant to help further understanding, and at the same time test the reader's broad knowledge of magnetics. Quite often, these problems are not necessarily a continuation of concepts discussed in that particular chapter, but rather unexpected questions about topics that require further study. This is to motivate the reader to look into unanticipated aspects of magnetics. Clearly, the goal is to

[1] *Schopenhauer. Brevier*, herausgegeben von Raymund Schmidt, Dieterich'schen Verlagsbuchhandlung zu Leipzig, S. 262, 1938.

deviate from the "spoonfeeding" that many students find comfortable, but is not appropriate for an academic education. However, this book is still an accessible starting point for someone interested in the broader area of magnetics, and can serve as an introductory course either at the late undergraduate or the early graduate level. After all, academic education has to keep up with today's increased complexity of technological developments.

The book begins with a first and second chapter introduction to some historical concepts that should make parts of the text more accessible. Some basic ideas of magnetics go back roughly fifty years or even a century in time, having experienced mainly bulk practical demonstrations. Nonetheless, these ideas find nowadays new avenues of expression as applications move to smaller scales of fabrication. For instance, magnetic domains and their wall movement have started to preoccupy once more those interested in new magnetic storage techniques, while the long researched spin of the electron is finally put to more ubiquitous use through new devices. Similarly, nondestructive techniques relying on micromagnetics and magnetic flux leakage have preoccupied the minds of many researchers for many decades, and for this reason their successful application to engineering applications is reviewed as we move on to Chap. 3. In view of their lasting endurance in the magnetic recording industry, the familiar magneto-optical recording and readout techniques are discussed in Chap. 4. On the other hand, some new magneto-optical applications mainly used for thin film characterization are mentioned as well, given that magnetic and optical interactions allow us to gain some valuable information about magnetization orientation or magnetization reversal. The many developments of the last century have revealed aspects of magnetism that some scientists and engineers may not be aware of. The treatment in Chap. 5 of the combined effects of electrical, thermal, and magnetic phenomena is trying to unveil precisely this lesser known aspect of magnetics, since it is easy for magnetics principles to be eclipsed by better known physical properties encountered in these applications. As the discussion in the book progresses, the number of new concepts increases, and more and more unfamiliar ideas may surface, such as the notion of a spin valve, elaborated on in Chap. 6. The best way to keep up is to maintain a broad interdisciplinary base of knowledge, whether through other academic courses or research. This adds a level of difficulty not always anticipated when reading the book, and will perhaps lead to some bumps in the road to understanding. Some knowledge of semiconductor device fabrication will come in handy, as well as familiarity with more laboratory-oriented growth techniques, in particular when reading Chap. 7 which deals with the newly emerged field of spin electronics. Prior exposure to at least basic quantum mechanics is a key requirement, as many quantum mechanical concepts, such as for instance, the Pauli exclusion principle, Fermi wavelength, and superposition of quantum states, are assumed to be familiar to the reader. But rest assured, all this is worth the trouble when the reader finally reaches Chap. 8 where the latest magnetic recording media developments are uncovered. Nevertheless, the discussion of the many fascinating subfields of magnetics is not coming to an end, even when the book does. As such, it continues to write many chapters through many other applications that are being developed every day.

Some of the discussed technologies such as quantum devices exist almost exclusively in the most advanced laboratories. There is hope that these technologies may replace one day the current type of semiconductor electronic devices. Unfortunately, until now the ever increasing speed of computers has thrown more and more obstacles in the way of the semiconductor industry. With nearly a billion transistors on an Intel Dual Core chip, following the familiar paths of optical lithography may become troublesome sooner than expected. This is because optical lithography depends on projecting light through stencil-like masks creating layer after layer of infinitesimal structures that become part of a transistor. Nevertheless, the wavelengths of lights currently used are merely too large to print the required dense patterns. Of course, tremendous research efforts have been spent and continue to be spent on developing systems with radiation beyond the visible spectrum, but regrettably they do not seem commercially viable. Alternative techniques such as double patterning lithography (i.e., doubling up the printed layers) have also emerged; however, it is not yet known how long they can keep up with the miniaturization of transistors. Advances in materials research combined with promising new areas in magnetics may offer ingenious solutions for overcoming these miniaturization barriers. Regrettably, for conventional semiconductor devices it may also mean replacing them, as new devices emerge with diversified functions that could take over some of the old, familiar tasks. However, many new device developments have encountered challenges of their own, because the actual construction of quantum devices that could perform at least the same tasks as electronic devices has proven to have its own difficulties. For the time being, the existence of such devices gives an indication of the direction of future technological developments that do not necessarily follow Moore's law that experts say is likely to hit a brick wall. If nothing else, these novel devices may provide spin-offs into further areas of magnetics.

The book is the work of Carmen-Gabriela Stefanita. A deep appreciation and gratitude go to Dr. Min Namkung of the NASA Goddard Space Flight Center, Greenbelt, Maryland, who has lent his valuable expertise to the discussion of some fundamental micromagnetics concepts.

Burlington, Massachusetts *Carmen-Gabriela Stefanita*

http://www.springer.com/978-3-642-22976-3

Magnetism
Basics and Applications
Stefanita, C.-G.
2012, XXIV, 336 p., Hardcover
ISBN: 978-3-642-22976-3