
Preface

The inspiration for this book can be traced back many years to two major works that influenced the author's outlook on applied physics: *Ferromagnetismus* by R. Becker, W. Döring (Springer, Berlin 1939), and *Ferromagnetism* by R.M. Bozorth (IEEE Press, New York 1951). The former work is a collection of lectures held in the 1930s for 'technicians' attending a technical college. The German language in which the work was originally written was extremely convenient for the author of this present book, as it was for a long time the only comfortable technical language in an English speaking environment. Later on, upon encountering the work by Bozorth, it was a relief to see the clarity and eloquence of the subjects presented in English, despite the impressive thickness of the book. Bozorth's work still constitutes a practical review for anyone in a multidisciplinary industry who comes across the various manifestations of magnetism. The popularity of both works is so enduring that they are regarded as highly academic, and yet extremely readable, a reference in their own right, still attracting many readers these days in industry and academia.

The field of magnetism progressed immensely in the twentieth century, and shows no signs of slowing down in the present one. It has become so vast that it is quite often viewed only in its parts, rather than as a whole. In today's myriad of applications, especially on a nanoscale, and their changeable implications mostly on a macroscale, it often seems that different aspects of reported work on magnetism are scattered and unrelated. Furthermore, the many atomic theories found in all major books on magnetism employ complex mathematical language that makes it less obvious how a theoretical description involving, e.g. spin can be associated with actual experimental observations.

The diverse expressions of magnetic phenomena on more than one scale, and the apparent confusion created by the overwhelming literature that treats disparate accounts of magnetism individually without placing them in a broader context, have led to the writing of this book. Based on the author's own struggle and experience in sifting through and organizing the vast amount

of information, this work addresses the relationship between individual topics in magnetism, trying to make the connection between magnetic phenomena on various scales more understandable. Nevertheless, the author makes no claims that the book comes even close to the work of the masters mentioned earlier. The intention of this author is only to show how the different sides of magnetism come together. For this reason, the focus of the book is only on a few selected topics that the author believes are more representative of the broader subject.

The book has an introductory chapter on some basic concepts in magnetism. A few of these are later ‘picked up’ in subsequent chapters, while others are not mentioned again. Nevertheless, just highlighting them once draws the reader’s attention to their existence and hints of their usefulness. The second chapter is an underpinning of magnetic nondestructive techniques, in particular magnetic Barkhausen noise, regarded by many as merely a laboratory nondestructive evaluation method. In any case, the valuable results and understanding gained through it have proved useful to more industrial nondestructive techniques such as Magnetic Flux Leakage and Remote Field Eddy Current. In the third chapter, the author takes a closer look at combined phenomena with wide industrial applications. The simple fact that optics and magnetism or piezoelectricity and magnetostriction can coexist has amazing consequences in many multidisciplinary areas. Furthermore, these subjects may recur in other established fields of magnetism, as implied in subsequent chapters. The fourth chapter goes deeper into the origins of ferromagnetism, showing that these constitute the foundation of emerging semiconductor electronics spin-offs (Chap. 5), as well as the recording heads in our everyday computers. The controversial and yet extremely promising field of spintronics is briefly described in Chap. 5, while some trends in magnetic recording media are tackled in Chap. 6.

Magnetism is used across many disciplines because of its rich implications in physics, chemistry, biochemistry, and the various areas of engineering. The author has undertaken to illustrate the various subfields in magnetism in a manner that anyone with a basic familiarity with modern physics can follow, regardless of their specialty. By no means is this book intended to be a comprehensive inclusion of all aspects of magnetism, nor does it have any claims that it treats the various areas in an exhaustive manner. On the contrary, this work is primarily intended to link the different areas of magnetism by showing how various phenomena fit into a broader picture. Its goal is to bring together a broad field in such a way that it provides a starting point for a graduate student or an experienced researcher for tackling a complex issue with maximum efficiency.

Collecting many sides of magnetism into a single volume had to be unavoidably selective; it is just an attempt at trying to spark an interest in this extended subject while keeping it together. Sometimes, this work has attempted to clarify the nature of macroscopic magnetic phenomena and how, in some cases, they can be traced back to a nanoscale. These days, the

popularity of nanotechnology may overshadow macro phenomena, although they are closely connected. Nanotechnology deals with the manipulation of materials on an atomic or molecular scale measured in billionths of a meter, while having manifestations on an every day scale. At other times, the spotlight of the book has been on explaining the physical nature of some basic magnetic phenomena, while illustrating the connection with real applications or contemporary research.

It is a pleasure to acknowledge the support and encouragement I have received from colleagues and friends without whom I may have never written this book. My thanks go to Profs. L. Clapham and D.L. Atherton, as well as Drs. J.-K. Yi and T. Krause who may have long have forgotten how it all started. More recently, Prof. S. Bandyopadhyay, and my collaborators Drs. M. Namkung, F. Yun, and S. Pramanik have left their intellectual imprint on this work, therefore my gratitude extends to them. I apologize to all those who have not been named. Rest assured your influence has played a tremendous role in shaping this book, and the many subjects tackled are a tribute to your work.

Lastly, it should be stated that the author does not endorse any of the commercial products discussed in this book. The products were only mentioned for historical reasons, or to illustrate a principle and explain some magnetics concepts.

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From Bulk to Nano

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