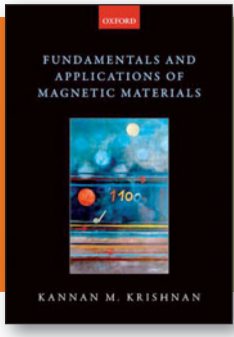


Fundamentals and Applications of Magnetic Materials

Kannan M. Krishnan

Oxford University Press, 2016
816 pages, $98.50 (e-book $97.99)
ISBN 9780199570447

This book covers a broad range of topics in magnetism and magnetic materials. There are other books on similar topics, but this one is the most comprehensive in its wide and thorough coverage of applications ranging from magnetic storage to spintronics to bio-related applications.

The book begins with a discussion of electromagnetism and an overview of different types of magnetism, followed by the atomic origin of magnetism and theoretical treatment for mechanisms producing various properties. Different from most other books in this field, there is no separate chapter on experimental measurement methods; rather, these methods are included in the discussion of related phenomena.

While the first 10 chapters focus on the fundamentals of magnetism and magnetic materials, the second half of the book covers different materials and their applications. Nanoscale magnetism and magnetic materials, fine nanoparticles, nanostructured materials, magnetic surfaces, and interfaces and their applications in biology and information storage are reviewed. Chapter 11's coverage of the more conventional soft and hard magnet materials is a little too brief, considering the growing importance of these materials for green energy applications. Each chapter starts with a brief summary of the topics to be covered and concludes with further reading, references, and exercises.

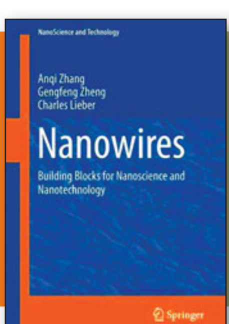
Despite the broad coverage of this book, most topics are discussed in depth. For example, techniques for imaging magnetic domains are extensively described—the most complete among all books on magnetism and magnetic materials—and the Stoner–Wohlfarth model is derived with excellent illustrations. The content is up to date and reflects the latest progress in research, especially for nanomagnetic materials. Most of the figures are extracted from other publications, but they are of high resolution and are explicit. The style of writing is clear and concise, and the material is well presented.

The complexity of magnetism makes it challenging to discuss each topic exclusively in one chapter. Such interdependence is presented in this book by placing cross-references, and readers are referred to other chapters/sections for more information about the topics.

The units and the choice of units in magnetism present a continual problem, in particular, for those who have little exposure to this subject. Although the International System of Units (SI) is highly recommended by international organizations, the centimeter–gram–second (CGS) system is still widely used by researchers and engineers. The author prefers the SI system, but the CGS form of most important equations and conclusions is also provided, and the CGS system is also used in figures and tables cited from other publications. However, for those who are not experienced, it might be difficult to comprehend the CGS system. It would have been helpful if the book had provided an appendix or chapter briefly explaining the relationship between these two systems.

Readers who have studied quantum mechanics and solid-state physics will find the discussion to be easy to follow. However, for those who have little or no such background, brief introductions with minimum mathematics are provided to elucidate the fundamental concepts prior to the profound descriptions. This is an excellent book for advanced undergraduate and graduate students, and researchers in the field.

Reviewer: ***Wanfeng Li****, research engineer of Research & Advanced Engineering, Ford Motor Co., USA.*



Nanowires: Building Blocks for Nanoscience and Nanotechnology

Anqi Zhang, Gengfeng Zheng, and Charles M. Lieber

Springer, 2016
321 pages, $129.00 (e-book $99.00)
ISBN 978-3-319-41979-4

This book thoroughly reviews all aspects of quasi-one-dimensional nanostructures, such as nanowires (NWs), from their synthesis methods to their properties and applications. The first chapter explains the importance of studying NWs, the physical concepts related to their formation, and some historical results on their synthesis. Chapter 2 describes the synthesis methods in a more systematic way, grouping them into vapor-phase growth-based methods, templated methods, and solution-based methods. Chapter 3 describes the physical properties of NWs and how to predict and control them. Their morphological or chemical characteristics are illustrated, and more complex structures, such as branched or kinked structures, are explained. Chapter 4 covers the possibility of assembling the grown NWs onto substrates by using microfluidic channels, Langmuir–Blodgett processes, or the blown bubble method, exploiting chemical interactions.

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The following seven chapters discuss applications. Chapter 5 extensively describes nanoelectronic devices based on NWs, such as field-effect transistors and diodes, logic gates, nonvolatile memories and nanoprocessors, and their electrical properties when fabricated using NWs. Chapter 6 describes NW-based photonic devices, such as lasers, light-emitting diodes, and photodetectors, starting with the description of the optical phenomena in homogeneous or heterostructured NWs. Chapter 7 discusses single or multiple quantum dots confined inside NWs through modulated doping or selecting metallic contacts, analyzing their effects such as the Coulomb blockade in experimental and simulated characteristics.

For renewable energy, it is important to have efficient and reliable energy-storage systems. Chapter 8 describes how NWs also provide building blocks for batteries, thanks to their ability to sustain the strain associated with the large volume expansion/discharge cycles and to remain connected to the current collectors during cycling instead of breaking, as occurs with standard materials. Chapter 9 addresses light harvesting effects observed in NWs for application in photovoltaics as well as the possibility to decouple light absorption from the optical path in the radial junction configuration. The two chapters discuss NW sensors and their applications when interfaced to biological systems.

In Chapter 1, it explains that by using vapor liquid solid growth under equilibrium conditions, it is not possible to grow NWs with sizes smaller than 0.2 μm. However, an article published in 1997 (J. Westwater et al., *J. Vac. Sci. Technol. B* **15** (3), 554 [1997]) and following ones demonstrate that the nucleation of NWs with diameters in the tens of nm in size and smaller can be obtained, their formation depending—in addition to the other parameters—on the partial pressure of the precursor gas. The reported explanation is that at low pressures, the chemical potential of the wire is higher than that of the vapor phase due to the high surface-to-volume ratio, and this prevents the wire nucleation in small eutectic droplets. When the pressure increases, the steam chemical potential increases as well, and the growth of small NWs becomes possible. This represents one weakness of the book, and the publisher could decide to publish a second edition with these data for more thorough coverage.

Despite this detail, the book is well worth reading. It is clear, well-organized, and informative. It is well focused on NWs and provides an overview of the extensive literature on this topic. The figures are useful and well-selected. The book requires background knowledge on materials science and nanofabrication, so it does not seem aimed at undergraduate students. It is helpful for researchers new to the field of NWs because it provides a useful list of many of the papers available on the subject. It is also useful to experts in the field because it stimulates ideas for new experiments.

Reviewer: Rosaria A. Puglisi, *Institute for Microelectronics and Microsystems of the National Research Council in Catania, Italy.*

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