

Preface

The field of magnetism has always steadily developed and new phenomena and/or new materials have appeared. These, we must study ourselves and teach to students. The time of lecture is limited, therefore we prefer to teach basic and fundamental matters rather than new ones. During the stay in the university as the faculty to teach magnetism to students, we realized the difficulty of teaching magnetism. After lecture hours we were asked by Dr. Ascheron, the editor of Springer, to write a book related to magnetism. At first we thought that we do have not enough ability to write a book of magnetism in English. But in recent years, all people are authors and the quality of the contents of a book are judged by the readers. In addition, due to having the co-authors, and not a single author, we accepted his proposal.

This book consists of three parts; part one gives the basis of magnetism, part two discusses magnetic materials and part three, spintronics. Part one includes chapters on magnetostatics, magnetism of atoms, magnetism of solids, exchange interactions, magnetic anisotropies, magnetostrictive effects, magnetic domain, and micromagnetism. Some relations of vector analysis, group theory, and second quantization, which are summarized in the corresponding appendices, are applied in some sections. Details of mathematical processes of some equations in the text are attached in the notes at the end of the section. To help readers who are not familiar with the objects, the relations in the appendices along with equations, figures, and tables in the text are referred in many parts of the text whenever they are used.

Part two is related to magnetic materials which are roughly classified as soft and hard magnetic materials. The fundamental properties of each are described. If both magnetic properties are understood well, we can apply them to individual materials.

Part three discusses spintronics, where the basic phenomena has been known for a long time, but the research field itself is new compared with parts one and two. Chapter 1 treats the history of magnetoresistance research and classification of magnetoresistance effect. Especially, theoretical and experimental treatments of magnetoresistance effect are described in detail. Chapter 2 focuses on the tunnel

magnetoresistance effect. After describing the historical background, development of MgO barrier tunnel magnetoresistance junction which triggered the giant tunnel magnetoresistance is described. Also, Heusler electrode tunnel junctions which are reported much after that is introduced. Chapter 3 is related to magnetic memory, especially the principle, development, and several issues about Magnetoresistive Random Access Memory (MRAM) research are described. In Chap. 4, accompanying technologies for the development of spintronics devices such as spin-polarization measurement and Gilbert damping constant, which are very important values in order to discuss the spin-dynamics of ferromagnets, are introduced.

This book can be used as a reference for researchers. Part one, which would also be useful for researchers, can be used as a textbook for post graduate students who have learned introductory magnetism, group theory, and advanced quantum mechanics. Being written at an advanced level we recommend undergraduate students who begin to learn magnetism to read a plainly written magnetic book first, such as *Physics of Ferromagnetism* (S. Chikazumi, Oxford university Press, 1997), before reading this part. Parts one and two, at least, would also be useful for engineers and technicians working in magnetic materials and devices.

Finally, we hope that this book will be much helpful for students who are beginners in the field of magnetism and also researchers who are now active in magnetic fields.

Sendai
Changchun

Terunobu Miyazaki
Hanmin Jin



<http://www.springer.com/978-3-642-25582-3>

The Physics of Ferromagnetism

Miyazaki, T.; Jin, H.

2012, XVI, 484 p., Hardcover

ISBN: 978-3-642-25582-3