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"Preface" to *Advanced Magnetic Nanostructures*

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PREFACE

A key trend in modern science and technology is the exploitation of phenomena occurring on length scales between 1 nm and 1000 nm. This nanotechnology or nanoscience approach has lead to the emergence of fields such as nanobiology, nanoelectronics, and nanochemistry. An important and—in many respects—pivotal area is *nanomagnetism*. From early precursors in the first half of the 20th century to recent developments, magnetic nanostructures are interesting scientific objects with many present and emerging applications, including permanent magnets, soft magnets, magnetic recording media, sensors, and structures and materials for spin electronics. A key advantage of artificial magnetic nanostructures is their ability to surpass the performance of naturally occurring magnetic compounds. Examples are nanostructured permanent and soft magnets.

Magnetic nanostructures can be produced in a variety of geometries, such as nanoparticles, nanowires, dots and antidots, particulate thin films, nanotubes, nanoj unctions, and nanorings. In addition, much progress has recently been made towards tuning the chemistry and crystallographic microstructure for a given geometry. For example, nanotubes can be produced as soft- and hard-magnetic structures.

A fascinating aspect of nanomagnetism is that the involved physics goes beyond a mixture of atomic-scale and macroscopic effects. The main competition between electrostatic interactions, such as exchange, and relativistic corrections, such as spin-orbit coupling, is organized on a length scale of a few nanometers. This gives rise to a variety of zero- and finite-temperature phenomena governing the static and dynamic behavior of the structures.

This book is devoted to the fabrication, characterization, experimental investigation, theoretical understanding, and utilization of advanced magnetic nanostructures. Focus is on various types of 'bottom-up' and 'top-down' artificial nanostructures, as contrasted to naturally occurring magnetic nanostructures, such as iron-oxide inclusions in magnetic rocks, and to structures such as perfect thin films.

Chapter 1 is an introduction into some basic concepts of interest to more than one chapter, such as the definitions of basic magnetic quantities. Chapters 2-4 are devoted to the theory of magnetic nanostructures, §5 deals with the characterization of the structures, and §6-10 are devoted to specific systems. Applications of advanced magnetic nanostructures are discussed in §11-15 and, finally, the appendix lists and briefly discusses magnetic properties of typical starting materials.

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