



**Spin Electronics**

# Spin Electronics

**Claude Fermon, Marcel Van de Voorde**



## **Spin Electronics:**

*Spin Electronics* Michael Ziese, Martin J. Thornton, 2007-06-30 For 50 years conventional electronics has ignored the electron spin. The manipulation and utilisation of the electron spin heralds an exciting and rapidly changing era in electronics combining the disciplines of magnetism and traditional electronics. The first generation of spintronic devices such as read heads based on giant magnetoresistance or non-volatile magnetic random access memories have already gained dominant positions in the market place. This volume the first of its kind on spin electronics describes all the essential topics for new researchers entering the field. It covers magnetism and semiconductor basics, micromagnetism, experimental techniques, materials science, device fabrication and new developments in spin-dependent processes. At the end of most chapters are a number of exercises and worked problems to aid the reader in understanding this fascinating new field. **Spin Electronics**

David D. Awschalom, Robert A. Buhrman, James M. Daughton, Stephan von Molnár, Michael L. Roukes, 2013-06-29 The history of scientific research and technological development is replete with examples of breakthroughs that have advanced the frontiers of knowledge but seldom does it record events that constitute paradigm shifts in broad areas of intellectual pursuit. One notable exception however is that of spin electronics also called spintronics, magnetoelectronics or magnetronics wherein information is carried by electron spin in addition to or in place of electron charge. It is now well established in scientific and engineering communities that Moore's Law having been an excellent predictor of integrated circuit density and computer performance since the 1970s now faces great challenges as the scale of electronic devices has been reduced to the level where quantum effects become significant factors in device operation. Electron spin is one such effect that offers the opportunity to continue the gains predicted by Moore's Law by taking advantage of the confluence of magnetism and semiconductor electronics in the newly emerging discipline of spin electronics. From a fundamental viewpoint spin polarization transport in a material occurs when there is an imbalance of spin populations at the Fermi energy. In ferromagnetic metals this imbalance results from a shift in the energy states available to spin-up and spin-down electrons. In practical applications a ferromagnetic metal may be used as a source of spin-polarized electrons to be injected into a semiconductor, a superconductor or a normal metal or to tunnel through an insulating barrier. **Concepts in Spin**

*Electronics* Sadamichi Maekawa, 2006-01-26 Nowadays information technology is based on semiconductor and ferromagnetic materials. Information processing and computation are based on electron charge in semiconductor transistors and integrated circuits and information is stored on magnetic high-density hard disks based on the physics of the electron spins. Recently a new branch of physics and nanotechnology called magnetoelectronics, spintronics or spin electronics has emerged which aims at simultaneously exploiting both the charge and the spin of electrons in the same device. A broader goal is to develop new functionality that does not exist separately in a ferromagnet or a semiconductor. The aim of this book is to present new directions in the development of spin electronics in both the basic physics and the technology which will become the

foundation of future electronics      **Spin Electronics** Michael Ziese, Martin J. Thornton, 2014-01-15      **Spintronics** Tomasz Blachowicz, Andrea Ehrmann, 2019-05-06 Starting from quantum mechanical and condensed matter foundations this book introduces into the necessary theory behind spin electronics Spintronics Equations of spin diffusion evolution and tunnelling are provided before an overview is given of simulation of spin transport at the atomic scale Furthermore applications are discussed with a focus on elementary spintronics devices such as spin valves memory cells and hard disk heads

**Spintronics** Tomasz Dietl, David D. Awschalom, Maria Kaminska, Hideo Ohno, 2009-02-12 This new volume focuses on a new exciting field of research Spintronics the area also known as spin based electronics The ultimate aim of researchers in this area is to develop new devices that exploit the spin of an electron instead of or in addition to its electronic charge In recent years many groups worldwide have devoted huge efforts to research of spintronic materials from their technology through characterization to modeling The resultant explosion of papers in this field and the solid scientific results achieved justify the publication of this volume Its goal is to summarize the current level of understanding and to highlight some key results and milestones that have been achieved to date Semiconductor spintronics is expected to lead to a new generation of transistors lasers and integrated magnetic sensors that can be used to create ultra low power high speed memory logic and photonic devices In addition development of novel devices such as spin polarized light emitters spin field effect transistors integrated sensors and high temperature electronics is anticipated Spintronics has emerged as one of the fastest growing areas of research This text presents an in depth examination of the most recent technological spintronic developments Includes contributions from leading scholars and industry experts      **Concepts in Spin Electronics** Sadamichi

Maekawa, 2006-01-26 Recently a new branch of physics and nanotechnology called The aim of this book is to which aims at simultaneously present new directions in the development of spin electronics in both the basic physics and the technology which will become the foundation of future electronics which will become the foundation of future electronics

*Spintronics for Next Generation Innovative Devices* Katsuaki Sato, Eiji Saitoh, 2015 Spintronics short for spin electronics or spin transport electronics exploits both the intrinsic spin of the electron and its associated magnetic moment in addition to its fundamental electronic charge in solid state devices Controlling the spin of electrons within a device can produce surprising and substantial changes in its properties Drawing from many cutting edge fields including physics materials science and electronics device technology spintronics has provided the key concepts for many next generation information processing and transmitting technologies This book discusses      **Nanomagnetism** Claude Fermon, Marcel Van de Voorde, 2017-03-17 This first book to focus on the applications of nanomagnetism presents those already realized while also suggesting bold ideas for further breakthroughs The first part is devoted to the concept of spin electronics and its use for data storage and magnetic sensing while the second part concentrates on magnetic nanoparticles and their use in industrial environment biological and medical applications The third more prospective part goes on to describe emerging applications

related to spin current creation and manipulation dynamics spin waves and binary logic based on nano scale magnetism With its unique choice of topics and authors this will appeal to academic as well as corporate researchers in a wide range of disciplines from physics via materials science to engineering chemistry and life science *Frontiers In Electronics* Sorin Cristoloveanu, Michael S Shur, 2009-08-06 *Frontiers in Electronics* contains the selected best papers presented at the Workshop on Frontiers in Electronics WOFE 07 This meeting was the fifth in the series of WOFE workshops and strongly reinforced the tradition of scientific quality and visionary research The issues addressed ranged from THz and infrared electronics to nanoelectronics and photonics The papers focused on the fabrication characterization and applications of nanodevices wide band gap structures and state of the art FETs The participants also discussed the device physics and processing issues including aspects related to SOI and germanium on insulator technologies TFTs and advanced CMOS and MOSFETs It is this cross pollination between different but related fields that made this conference very special This book which goes beyond the publication of the WOFE Proceedings includes full length invited papers selected at the conference and reviewed by international leaders The book is divided into four distinct sections with the common denominator throughout being the nano device present under various metamorphoses in the wide CMOS and optoelectronics arena a

*Mesoscopic Electronics in Solid State Nanostructures* Thomas Heinzel, 2008-07-11 This text treats electronic transport in the regime where conventional textbook models are no longer applicable including the effect of electronic phase coherence energy quantization and single electron charging This second edition is completely updated and expanded and now comprises new chapters on spin electronics and quantum information processing transport in inhomogeneous magnetic fields organic molecular electronics and applications of field effect transistors The book also provides an overview of semiconductor processing technologies and experimental techniques With a number of examples and problems with solutions this is an ideal introduction for students and beginning researchers in the field This book is a useful tool too for the experienced researcher to get a summary of recent developments in solid state nanostructures I applaud the author for a marvellous contribution to the scientific community of mesoscopic electronics Prof K Ensslin Solid State Physics Laboratory ETH Zurich **Visions of the Future: Physics and Electronics** J. M. T. Thompson, 2001-07-02 Leading young scientists

give engaging reviews of their research areas and exciting visions of future developments **Mechanical Properties of Complex Intermetallics** Esther Belin-Ferr<sup>2</sup>, 2011 This book will be the last one in a series of 4 books issued yearly as a deliverable of the research school established within the European Network of Excellence CMA for Complex Metallic Alloys It is written by reputed experts in the fields of metal physics surface physics and chemistry metallurgy and process engineering combining expertise found inside as well as outside the network The CMA network focuses on the huge group of largely unknown multinary alloys and compounds formed with crystal structures based on giant unit cells containing clusters with many tens up to more than thousand atoms per unit cell In these phases for many phenomena the physical length scales are

substantially smaller than the unit cell dimension Hence these materials offer unique combinations of properties which are mutually excluded in conventional materials metallic electric conductivity combined with low thermal conductivity combination of good light absorption with high temperature stability combination of high metallic hardness with reduced wetting by liquids electrical and thermal resistance tuneable by composition variation excellent resistance to corrosion reduced cold welding and adhesion enhanced hydrogen storage capacity and light absorption etc The series of books will concentrate on development of fundamental knowledge with the aim of understanding materials phenomena technologies associated with the production transformation and processing of knowledge based multifunctional materials surface engineering support for new materials development and new knowledge based higher performance materials for macro scale applications

**Spintronic Materials and Technology** Yongbing Xu, Sarah Thompson, 2006-10-25 Few books exist that cover the hot field of second generation spintronic devices despite their potential to revolutionize the IT industry Compiling the obstacles and progress of spin controlled devices into one source Spintronic Materials and Technology presents an in depth examination of the most recent technological spintronic developmen Ultrathin Magnetic Structures IV Bretislav Heinrich, J.A.C. Bland, 2004-12-13 The ability to understand and control the unique properties of interfaces has created an entirely new field of magnetism which already has a profound impact in technology and is providing the basis for a revolution in electronics The last decade has seen dramatic progress in the development of magnetic devices for information technology but also in the basic understanding of the physics of magnetic nanostructures Volume III describes thin film magnetic properties and methods for characterising thin film structure topics that underpin the present spintronics revolution in which devices are based on combined magnetic materials and semiconductors The present volume IV deals with the fundamentals of spintronics magnetoelectronic materials spin injection and detection micromagnetics and the development of magnetic random access memory based on GMR and tunnel junction devices Together these books provide readers with a comprehensive account of an exciting and rapidly developing field The treatment is designed to be accessible both to newcomers and to experts already working in this field who would like to get a better understanding of this very diversified area of research

*Magnetism in Condensed Matter* Stephen Blundell, 2001-10-05 An understanding of the quantum mechanical nature of magnetism has led to the development of new magnetic materials which are used as permanent magnets sensors and in information storage Behind these practical applications lie a range of fundamental ideas including symmetry breaking order parameters excitations frustration and reduced dimensionality This superb new textbook presents a logical account of these ideas starting from basic concepts in electromagnetism and quantum mechanics It outlines the origin of magnetic moments in atoms and how these moments can be affected by their local environment inside a crystal The different types of interactions which can be present between magnetic moments are described The final chapters of the book are devoted to the magnetic properties of metals and to the complex behaviour which can occur when competing magnetic

interactions are present and or the system has a reduced dimensionality Throughout the text the theoretical principles are applied to real systems There is substantial discussion of experimental techniques and current research topics The book is copiously illustrated and contains detailed appendices which cover the fundamental principles

*Electron Transport in Quantum Dots* Jonathan P. Bird, 2013-11-27 When I was contacted by Kluwer Academic Publishers in the Fall of 200 I inviting me to edit a volume of papers on the issue of electron transport in quantum dots I was excited by what I saw as an ideal opportunity to provide an overview of a field of research that has made significant contributions in recent years both to our understanding of fundamental physics and to the development of novel nanoelectronic technologies The need for such a volume seemed to be made more pressing by the fact that few comprehensive reviews of this topic have appeared in the literature in spite of the vast activity in this area over the course of the last decade or so With this motivation I set out to try to compile a volume that would fairly reflect the wide range of opinions that has emerged in the study of electron transport in quantum dots Indeed there has been no effort on my part to ensure any consistency between the different chapters since I would prefer that this volume instead serve as a useful forum for the debate of critical issues in this still developing field In this matter I have been assisted greatly by the excellent series of articles provided by the different authors who are widely recognized as some of the leaders in this vital area of research

**Aspects of Modern Magnetism** Y. J. Wang, C. H. Shang, 1996 This book a collection of works by leading figures in the field is devoted to the latest developments of modern magnetism including micromagnetism nanomagnetic materials magnetic multilayers macroscopic quantum magnetism rare earth intermetallic compounds giant magnetoresistance and their applications Some new concepts and theories are also included for a better understanding of these novel phenomena This book can be used as an advanced text book on magnetism and materials science for graduate students in physics and materials science departments It is also useful as a research reference for condensed matter physicists and materials scientists

**Electronic Devices Architectures for the NANO-CMOS Era** Simon Deleonibus, 2019-05-08 In this book internationally recognized researchers give a state of the art overview of the electronic device architectures required for the nano CMOS era and beyond Challenges relevant to the scaling of CMOS nanoelectronics are addressed through different core CMOS and memory device options in the first part of the book The second part reviews new device concepts for nanoelectronics beyond CMOS The book covers the fundamental limits of core CMOS improving scaling by the introduction of new materials or processes new architectures using SOI multigates and multichannels and quantum computing

**Advanced Electrical and Electronics Materials** K. M. Gupta, Nishu Gupta, 2015-03-06 This comprehensive and unique book is intended to cover the vast and fast growing field of electrical and electronic materials and their engineering in accordance with modern developments Basic and pre requisite information has been included for easy transition to more complex topics Latest developments in various fields of materials and their sciences engineering processing and applications have been included Latest topics like PLZT vacuum as insulator

fiber optics high temperature superconductors smart materials ferromagnetic semiconductors etc are covered Illustrations and examples encompass different engineering disciplines such as robotics electrical mechanical electronics instrumentation and control computer and their inter disciplinary branches A variety of materials ranging from iridium to garnets microelectronics micro alloys to memory devices left handed materials advanced and futuristic materials are described in detail



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