



Electrical charge current in a heavy non-magnetic metal (HM) is converted into spin current under the influence of spin-orbit coupling, known as **spin Hall effect**. The spin current will exert **spin-orbit torques (SOT)** on the magnetization vector of a neighboring magnetic thin film, causing dynamics or potentially magnetic switching.

# Spin Electronics

**Supriyo Bandyopadhyay, Marc Cahay**



## **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. **Spin Electronics** Michael Ziese, Martin J. Thornton, 2014-01-15 **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 *Spin Current* Sadamichi Maekawa, Sergio O. Valenzuela, Eiji Saitoh, 2012-07-26 In a new branch of physics and technology called spin

electronics or spintronics the flow of electrical charge usual current as well as the flow of electron spin the so called spin current are manipulated and controlled together This book is intended to provide an introduction and guide to the new physics and application of spin current

**Concepts in Spin Electronics** Sadamichi Maekawa,2006-01-26 Recently a new branch of physics and nanotechnology called The aim of this book is tod which aims at simultaneously present new directions in the development of spin electronics in both the basic physics and the technologywhich will become the foundation of future electronics ich will become the foundation of future electronics

**Spintronics** Puja Dey,Jitendra Nath Roy,2021-04-13 This book highlights the overview of Spintronics including What is Spintronics Why Do We Need Spintronics Comparative merit demerit of Spintronics and Electronics Research Efforts put on Spintronics Quantum Mechanics of Spin Dynamics of magnetic moments Landau Lifshitz Gilbert Equation Spin Dependent Band Gap in Ferromagnetic Materials Functionality of Spin in Spintronics Different Branches of Spintronics etc Some important notions on basic elements of Spintronics are discussed here such as Spin Polarization Spin Filter Effect Spin Generation and Injection Spin Accumulation Different kinds of Spin Relaxation Phenomena Spin Valve Spin Extraction Spin Hall Effect Spin Seebeck Effect Spin Current Measurement Mechanism Magnetoresistance and its different kinds etc Concept of Giant Magnetoresistance GMR different types of GMR qualitative and quantitative explanation of GMR employing Resistor Network Theory are presented here Tunnelling Magnetoresistance TMR Magnetic Junctions Effect of various parameters on TMR Measurement of spin relaxation length and time in the spacer layer are covered here This book highlights the concept of Spin Transfer Torque STT STT in Ferromagnetic Layer Structures STT driven Magnetization Dynamics STT in Magnetic Multilayer Nanopillar etc This book also sheds light on Magnetic Domain Wall MDW Motion Ratchet Effect in MDW motion MDW motion velocity measurements Current driven MDW motion etc The book deals with the emerging field of spintronics i e Opto spintronics Special emphasis is given on ultrafast optical controlling of magnetic states of antiferromagnet Spin photon interaction Faraday Effect Inverse Faraday Effect and outline of different all optical spintronic switching One more promising branch i e Terahertz Spintronics is also covered Principle of operation of spintronic terahertz emitter choice of materials terahertz writing of an antiferromagnetic magnetic memory device is discussed Brief introduction of Semiconductor spintronics is presented that includes dilute magnetic semiconductor feromagnetic semiconductor spin polarized semiconductor devices three terminal spintronic devices Spin transistor Spin LED and Spin Laser This book also emphasizes on several modern spintronics devices that includes GMR Read Head of Modern Hard Disk Drive MRAM Position Sensor Biosensor Magnetic Field sensor Three Terminal Magnetic Memory Devices Spin FET Race Track Memory and Quantum Computing

**Introduction to Spintronics** Supriyo Bandyopadhyay,Marc Cahay,2015-09-18 Introduction to Spintronics provides an accessible organized and progressive presentation of the quantum mechanical concept of spin and the technology of using it to store process and communicate information Fully updated and expanded to 18 chapters featuring many new drill problems this edition reflects

the explosion of study in spin related physics addressing seven important physical phenomena with spintronic device applications It discusses spintronics without magnetism which allows one to manipulate spin currents by purely electrical means It explores lateral spin orbit interaction and its many nuances as well as the possibility to implement spin polarizers and analyzers using quantum point contacts It also introduces the concept of single domain nanomagnet based computing

*Magnetization Dynamics in Diluted Magnetic Semiconductor Heterostructures* Martin Kneip, 2009-02-17 Doctoral Thesis Dissertation from the year 2008 in the subject Physics Theoretical Physics grade sehr gut 1 0 University of Dortmund language English abstract In this thesis spin dynamics in Zn Mn Se Zn Be Se and Cd Mn Te Cd Mg Te DMS quantum well heterostructures with a type I band alignment are studied where the carriers are quantum confined Especially the important role of free carriers in heating of the Mn system by its interaction with photoexcited carriers with excess kinetic energy and in the cooling of the Mn system in the presence of cold background carriers provided by modulation doping is established The studies are separated in three chapters In the fourth chapter of this thesis new results on energy and spin transfer between free carriers and Mn ion system are presented Contributions of direct heating of the Mn system by photocarriers and indirect heating via nonequilibrium phonons are distinguished and their competition is discussed In the fifth chapter dynamics of spin lattice relaxation of magnetic Mn ions in DMS QW heterostructures is investigated and new experimental studies on Zn Mn Se Zn Be Se heterostructures are shown Crucial for spintronic devices is the ability to tune the spin relaxation time precisely as the spin relaxation time is important in double respects On the one hand spin polarization must be conserved over long times and distances if the spin shall be processed or stored in a region which is spatial separated from the spin injector Especially for the possibility of utilizing spins as quantum bits for quantum information processing long spin polarization is needed On the other hand short spin relaxation time is needed for fast switching between different spin states For instance semiconductor lasers can be switched off extremely fast by reorientation of spin This very relevant topic is devoted the sixth chapter before the thesis is summarized in the last chapter Especially for one of the biggest drawbacks for precise tuning that the magnetization dynamics in DMS cannot be controlled separately from the static magnetization solutions via electric field control of the magnetization dynamics or via the technological concept of digital alloying are presented precise tuning that the magnetization dynamics in DMS cannot be controlled separately from the static magnetization solutions via electric field control of the magnetization dynamics or via the technological concept of digital alloying are presented

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*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

IEICE Transactions on Electronics ,2008  
Look Japan ,2002

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**Spin-dependent Transport in Ferromagnetic Oxide-based Tunnel Junctions**  
Jin-Seo Noh,2003      *Composition Controlled Spin Polarization in Co<sub>1-x</sub>Fe<sub>x</sub>S<sub>2</sub>* Lan Wang,2005

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