
Handbook of Spintronics

Yongbing Xu • David D. Awschalom
Junsaku Nitta
Editors

Handbook of Spintronics

With 807 Figures and 36 Tables

 Springer Reference

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Preface

The IT industry has followed Moore's Law for decades, successfully predicting the number of transistors on a chip doubles about every 2 years, and has changed almost every aspect of our life. To keep electronics development at the pace of the Moore's Law, revolutionary technologies are needed. Spintronics is a promising area of science and technology that may impact both near- and long-term electronics. While conventional semiconductor devices rely on the electron charge and the magnetic data storage media on electron spin, spintronics exploits both charge and spin to achieve new functionality. Many spintronic devices are non-volatile, fast and energy efficient, and are likely to impact many industries including mass data storage, micro/nano electronics and bio-medical sensors. The Magnetic RAM (MRAM), for example, may combine the functions of both DRAM and SRAM.

Spintronics is a multidisciplinary and fast growing research area. The research is closely related to physics, chemistry, materials science, device fabrication, electrical engineering, and computer science and system integration. The discovery of Giant Magnetoresistance (GMR) in the magnetic metallic multilayers in the early eighties initiated metallic spintronic research. The following research into Tunneling Magnetoresistance (TMR) effect in metallic/oxide spin valves has led to the development of MRAM. The research of diluted magnetic semiconductors and hybrid structures is leading the way of developing a spin-FET, capable of both data storage and processing. Recent exciting research into coherent spin manipulation in graphene, diamond, topological insulators and other 2D materials will speed up the development of quantum information processing and new generation of quantum spintronics, beyond our imagination.

This "Handbook of Spintronics" seeks to cover many important aspects of spintronics research with contributions from world leading scientists in these areas. We are grateful to all the authors, our associate editors and all the member

of the advisory board for their time and contributions. We would also like to thank Tom Spicer, Abhijit Baroi and the publication team of Springer for their great efforts in publishing this book.

York, UK
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Chicago, IL, USA
June 2015

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David D. Awschalom Professor Awschalom received his B.Sc. in physics from the University of Illinois at Urbana-Champaign, and his Ph.D. in experimental physics from Cornell University. He was a Research Staff member and Manager of the Nonequilibrium Physics Department at the IBM Watson Research Center in Yorktown Heights, New York. In 1991 he joined the University of California-Santa Barbara as a Professor of Physics, and was appointed as a Professor of Electrical and Computer Engineering. During that period he served as the Peter J. Clarke Professor and Director of the California NanoSystems Institute, and Director of the Center for Spintronics and Quantum Computation. Professor Awschalom is currently the Liew Family Professor in Spintronics and Quantum Information within the Institute for Molecular Engineering at the University of Chicago.

His research in quantum spintronics involves understanding and controlling the spin of electrons and nuclei for fundamental studies of matter at the atomic scale, advanced computing, molecular imaging, and nanometer-scale sensing technologies. His group has research activities in optical and magnetic interactions in semiconductor quantum structures, spin dynamics and coherence in condensed matter systems, macroscopic quantum phenomena in nanometer-scale magnets, and implementations of quantum information processing in the solid state. He has developed a variety of femtosecond-resolved spatiotemporal spectroscopies and micromagnetic sensing techniques aimed at exploring charge and spin motion in the quantum domain.

Professor Awschalom received an IBM Outstanding Innovation Award, the Outstanding Investigator Prize from the Materials Research Society, the International Magnetism Prize and Néel Medal from the International Union of Pure and Applied Physics, the Oliver E. Buckley Prize from the American Physical Society, the Agilent Europhysics Prize from the European Physical Society, the Newcomb Cleveland Prize from the American Association for the Advancement of Science, the UC Faculty Research Lecturer Award, the David Turnbull Award from the Materials Research Society, and the Julius Edgar Lilienfeld Prize from the American Physical Society. Professor Awschalom is a Fellow of the American Physical Society and the American Association for the Advancement of Science. He is a member of the American Academy of Arts and Sciences, the National Academy of Sciences, the National Academy of Engineering, and the European Academy of Sciences.

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