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Nota di contenuto	Cover -- Title Page -- Copyright Page -- Contents -- Preface -- Chapter 1. Tunnel Field-Effect Transistors Based on III-V Semiconductors -- 1.1. Introduction -- 1.2. Experiments -- 1.3. Simulation of III-V-based TFETs -- 1.3.1. The k.p model in the NEGF formalism -- 1.4. SS degradation mechanisms -- 1.4.1. Electrostatic integrity -- 1.4.2. Trap-assisted tunneling -- 1.4.3. Surface roughness -- 1.5. Strategies to improve the on-state current -- 1.5.1. Strain -- 1.5.2. Broken-gap hetero-structures -- 1.5.3. Molar fraction grading of the source material -- 1.6. Conclusion -- 1.7. References -- Chapter 2. Field-Effect Transistors Based on 2D Materials: A Modeling Perspective -- 2.1. Introduction -- 2.1.1. Future of Moore's law -- 2.1.2. The potential of 2D materials -- 2.2. Modeling approach -- 2.2.1. Requirements and state of the art -- 2.2.2. Maximally localized Wannier functions (MLWFs) -- 2.2.3. Towards ab initio quantum transport simulations -- 2.3. 2D device performance analysis -- 2.3.1. MoS2 and other TMDs -- 2.3.2. Novel 2D materials -- 2.4. Challenges and opportunities -- 2.4.1. Electrical contacts between metals and 2D monolayers -- 2.4.2. 2D mobility limiting factors -- 2.4.3. 2D oxides -- 2.4.4. Advanced logic concepts -- 2.5. Conclusion and outlook -- 2.6. Acknowledgments -- 2.7. References -- Chapter 3. Negative Capacitance Field-Effect Transistors -- 3.1. Introduction -- 3.2. The rise of NC-FETs -- 3.3. Understanding NC-FETs from scratch -- 3.3.1.

Electrostatics in a generic NC-FET -- 3.3.2. Formulating switching slope of a generic NC-FET -- 3.4. Fundamental challenges of NC-FET -- 3.4.1. NC does not help good FETs -- 3.4.2. Quantum capacitance may "kill" NC-FETs -- 3.5. Design and optimization of NC-FET -- 3.5.1. Designing NC-FET in the quantum capacitance limit -- 3.5.2. The role of NC nonlinearity. 3.5.3. IMG: borrow parasitic charge for polarization in NC -- 3.5.4. A practical role of NC for FETs: voltage-loss saver -- 3.6. Appendix: A rule for polarization dynamics-based interpretation of the subthermionic SS -- 3.7. References -- Chapter 4. Z2 Field-Effect Transistors -- 4.1. Introduction -- 4.2. Z2FET steady-state operation -- 4.2.1. Z2FET sharp switch evidence -- 4.2.2. Z2FET "S-shape" characteristic -- 4.2.3. Z2FET detailed description -- 4.3. Z2FET steady-state analytical and compact model -- 4.3.1. Z2FET steady-state analytical drain current model -- 4.3.2. Z2FET analytical evaluation of switching voltage -- 4.3.3. Z2FET compact model -- 4.4. Z2FET experimental evidence -- 4.4.1. Z2FET fabrication -- 4.4.3. Z2FET switching characteristic under gate sweep -- 4.4.4. Z2FET switching characteristic under drain sweep -- 4.5. Z2FET as 1T-DRAM -- 4.5.1. Z2FET 1T-DRAM operation description -- 4.5.2. Z2FET 1T-DRAM operation experimental evidence -- 4.6. Z2FET structure optimization -- 4.6.1. Z2FET DGP -- 4.6.2. Z3FET -- 4.7. Z2FET advanced applications -- 4.7.1. Z2FET as ESD -- 4.7.2. Z2FET as logic switch -- 4.7.3. Z2FET as photodetector -- 4.8. Conclusion -- 4.9. References -- Chapter 5. Two-Dimensional Spintronics -- 5.1. Introduction -- 5.2. Spintronics in 2D Rashba gases at oxide surfaces-interfaces -- 5.2.1. Emergent 2D conductivity at oxide interfaces -- 5.2.2. Rashba spin-orbit interactions -- 5.2.3. Spin-to-charge current conversion in oxide 2DEGs -- 5.2.4. Device applications and prospects -- 5.3. Spintronics in lateral spin devices in 2D materials -- 5.3.1. Introduction -- 5.3.2. Spin injection and detection -- 5.3.3. Spin precession -- 5.3.4. Mechanisms of spin relaxation -- 5.3.5. Spin transport in van der Waals heterostructures -- 5.4. 2D materials in magnetic tunnel junctions -- 5.4.1. Introduction. 5.4.2. First steps towards 2D material integration in magnetic tunnel junctions -- 5.4.3. Exfoliated and transferred devices: early results -- 5.4.4. Exfoliated and transferred devices: improvement through in situ definition -- 5.4.5. Direct CVD growth: the rise of large scale and high quality -- 5.4.6. Experimental evidences of 2D-based spin filtering in hybrid 2D-MTJs -- 5.4.7. Conclusion -- 5.5. Topological insulators in spintronics -- 5.5.1. Introduction -- 5.5.2. Spin-momentum locking and spin-charge interconversion -- 5.5.3. Materials, interfaces and fabrication methods -- 5.5.4. Spin-charge interconversion measurements -- 5.5.5. Conclusion and outlook -- 5.6. References -- Chapter 6. Valleytronics in 2D Materials -- 6.1. Introduction -- 6.2. Exciton and valley physics -- 6.2.1. Introduction to valleys and excitons -- 6.2.2. Valley physics -- 6.2.3. Spin orbit coupling and exotic excitons -- 6.3. Valley lifetime, transport and operations -- 6.3.1. Valley lifetime -- 6.3.2. Valley transport -- 6.3.3. Valley operations -- 6.4. Valleytronic devices and materials -- 6.5. Valleytronic computing -- 6.5.1. Classical computing - power and performance -- 6.5.2. Classical computing - architecture -- 6.5.3. Quantum computing -- 6.5.4. Outlook -- 6.6. References -- Chapter 7. Molecular Electronics: Electron, Spin and Thermal Transport through Molecules -- 7.1. Introduction -- 7.2. How to make a molecular junction -- 7.3. Electron transport in molecular devices: back to basics -- 7.4. Electron transport: DC and low frequency -- 7.5. Electron transport at high frequencies -- 7.6. Spin-dependent electron transport in molecular

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Sommario/riassunto

Recent advances in physics, material sciences and technology have allowed the rise of new paradigms with bright prospects for digital electronics, going beyond the reach of Moore's law, which details the scaling limit of electronic devices in terms of size and power. This book presents original and innovative topics in the field of beyond CMOS electronics, ranging from steep slope devices and molecular electronics to spintronics, valleytronics, superconductivity and optical chips. Written by globally recognized leading research experts, each chapter of this book will provide an introductory overview of their topic and illustrate the state of the art and future challenges. Aimed not only at students and those new to this field, but also at well-experienced researchers, Beyond-CMOS provides extremely clear and exciting perspectives about the technology of tomorrow, and is thus an effective tool for understanding and developing new ideas, materials and architectures.
