2d Materials And Van Der Waals Heterostructures Arxiv

Modern materials science builds on knowledge from physics, chemistry, biology, mathematics, computer and data science, and engineering sciences to enable us to understand, control, and expand the material world. Although it is anchored in inquiry-based fundamental science, materials research is strongly focused on discovering and producing reliable and economically viable materials, from super alloys to polymer composites, that are used in a vast array of products essential to today's societies and economies. Frontiers of Materials Research: A Decadal Survey is aimed at documenting the status and promising future directions of materials research in the United States in the context of similar efforts worldwide. This third decadal survey in materials research reviews the progress and achievements in materials research and changes in the materials research landscape over the last decade; research opportunities for investment for the period 2020-2030; impacts that materials research has had and is expected to have on emerging technologies, national needs, and science; and challenges the enterprise may face over the next decade.

Nowadays nanoscience and nanotechnologies provide us with many excellent examples of the unique solutions for the different technical problems and demands of human society. Smart stimuli-responsive nanosystems and nanomaterials are used in many fields such as medicine, biomedical, biotechnology, agriculture, environmental pollution control, cosmetics, optics, health, food, energy, textiles, automotive, communication technologies, agriculture, and electronics. The book “Smart Nanosystems for Biomedicine, Optoelectronics and Catalysis” describes the modern trends in nanoscience and nanotechnology for creation of smart hybrid nanosystems combining the inorganic nano-objects with organic, biological, and biocompatible materials, which create multifunctional and remotely controlled platforms for diverse technical and biomedical uses. The material includes several review and original research articles devoted to the problems of directed chemical and biological synthesis of such nanosystems, thorough analysis of their physical and chemical properties and prospects of their possible applications. We hope that the presented book will be useful for different nanoscience research groups and PhD and graduate students, to introduce them to the world of hybrid metal-organic and metal-biological nano-objects, and smart self-organizing nanosystems and open new ways of their possible use in different scientific and practical areas.

Micro/nano-mechanical systems are a crucial part of the modern world providing a plethora of sensing and actuation functionalities used in everything from the largest cargo ships to the smallest hand-held electronics; from the most advanced scientific and medical equipment to the simplest household items. Over the past few decades, the processes used to produce these devices have improved, supporting dramatic reductions in size, but there are fundamental limits to this trend that require a new production paradigm. The 2004 discovery of graphene ushered in a new era of condensed matter physics research, that of two-dimensional materials. Being only a few atomic layers thick, this new class of materials exhibit unprecedented mechanical strength and flexibility and can couple to electric, magnetic and optical signals. Additionally, they can be combined to form van der Waals heterostructures in an almost limitless number of ways. They are thus ideal candidates to reduce the size and extend the capabilities of traditional micro/nano-mechanical systems and are poised to redefine the technological sphere. This thesis attempts to develop the framework and protocols required to produce and characterise micro/nano-mechanical devices made from two-dimensional materials. Graphene and its insulating analogue, hexagonal boron nitride, are the most widely studied materials and their heterostructures are used as the test-bed for potential device architectures and capabilities. Interlayer friction, electro-mechanical actuation and surface reconstruction are some of the key phenomena investigated in this work.

Fundamentals and Sensing Applications of 2D Materials provides a comprehensive understanding of a wide range of 2D materials. Examples of fundamental topics include: defect and vacancy engineering, doping and advantages of 2D materials for sensing, 2D materials and composites for sensing, and 2D materials in biosystems. A wide range of applications are addressed, such as gas sensors based on 2D materials, electrochemical glucose sensors, biosensors (enzymatic and non-enzymatic), and printed, stretchable, wearable and flexible biosensors. Due to their sub-nanometer thickness, 2D materials have a high packing density, thus making them suitable for the fabrication of thin film based sensor devices. Benefiting from their unique physical and chemical properties (e.g. strong mechanical strength, high surface area, unparalleled thermal conductivity, remarkable biocompatibility and ease of functionalization), 2D layered nanomaterials have shown great potential in designing high performance sensor devices. Provides a comprehensive overview of 2D materials systems that are relevant to sensing, including transition metal dichalcogenides, metal oxides, graphene and other 2D materials system Includes information on potential applications, such as flexible sensors, biosensors, optical sensors, electrochemical sensors, and more Discusses graphene in terms of the lessons learned from this material for sensing applications and how these lessons can be applied to other 2D materials

The advent of graphene and, more recently, two-dimensional materials has opened new perspectives in electronics, optoelectronics, energy harvesting, and sensing applications. This book, based on a Special Issue published in Nanomaterials – MDPI covers experimental, simulation, and theoretical research on 2D materials and their van der Waals heterojunctions. The emphasis is the physical properties and the applications of 2D materials in state-of-the-art sensors and electronic or optoelectronic devices.

This volume presents a comprehensive perspective on the global scientific, technological, and societal impact of nanotechnology since 2000, and explores the opportunities and research directions in the next decade to 2020. The vision for the future of nanotechnology presented here draws on scientific insights from U.S. experts in the field, examinations of lessons learned, and international perspectives shared by participants from 35 countries in a series of high-level workshops organized by Mike Roco of the National Science Foundation (NSF), along with a team of American co-hosts that includes Chad Mirkin, Mark Hersam, Evelyn Hu, and several other eminent U.S. scientists. The study performed in support of the U.S. National Nanotechnology Initiative (NNI) aims to redefine the R&D goals for nanoscale science and engineering integration and to establish nanotechnology as a general-purpose technology in the next decade. It intends to provide decision makers in academia, industry, and government with a nanotechnology community perspective of productive and responsible paths forward for nanotechnology R&D.

This book surveys semiconductor superlattices, in particular their growth and electronic properties in an applied electric field perpendicular to the layers. The main developments in this field, which were achieved in the last five to seven years, are summarized. The electronic properties include transport through minibands at low electric field strengths, the Wannier–Stark localization and Bloch oscillations at intermediate electric field strengths, resonant tunneling of electrons and holes between different subbands, and the formation of electric field domains for large carrier densities at high electric field strengths. Contents: Growth and Characterization (K Fujiwara)Miniband Transport (A Sibille)Wannier–Stark Localization and Bloch Oscillations (F Agulló-Rueda & J Feldmann)Resonant Tunneling (H Grahn)Electric Field Domains (H Grahn). Readership: Physicists and materials scientists. keywords:Semiconductor Superlattices;Nanostructures;Fabrication;Miniband Transport;Bloch Oscillations;Wannierâ€“Stark Localization;Resonant Tunneling;Electric-Field Domains;Non-Linear Transport;Optical Properties

This book describes the rapidly expanding field of two-dimensional (2D) transition metal carbides and nitrides (MXenes). It covers fundamental knowledge on synthesis, structure, and properties of these new materials, and a description of their processing, scale-up and emerging applications. The ways in which the quickly expanding family of MXenes can outperform other novel nanomaterials in a variety of applications, spanning from energy storage and conversion to electronics; from water science to transportation; and in defense and medical applications, are discussed in detail.

Emerging 2D Materials and Devices for the Internet of Things: Information, Sensing and Energy Applications summarizes state-of-the-art technologies in applying 2D layered materials, discusses energy and sensing device applications as essential infrastructure solutions, and explores designs that will make internet-of-things devices faster, more reliable and more accessible for the creation of mass-market products. The book focuses on information, energy and sensing applications, showing how different types of 2D materials are being used to create a new generation of products and devices that harness the capabilities of wireless technology in an eco-efficient, reliable way. This book is an important resource for both materials scientists and engineers, who are designing new wireless products in a variety of industry sectors. Explores how 2D materials are being used to create faster and more reliable wireless network solutions Discusses how graphene-based nanocomposites are being used for energy harvesting and storage applications Outlines the major challenges for integrating 2D materials in electronic sensing devices

Two-dimensional (2D) materials are a family of materials that are atomically thin, with ultra-high surface-to-volume ratio. Multiple 2D materials can be held together by van der Waals interaction to build layered heterostructures. Since the first experimental isolation of a 2D material graphene in 2004, 2D materials have attracted much attention as promising candidate materials for future nanoscale devices. In the first part of the dissertation, I focus on a unique property of a small subset of 2D transition metal dichalcogenide (TMD) monolayers: the potential to exist in multiple competing crystal structures. Phase change materials have wide spread applications from electronics, optics to energy technology. Here, I study the structural phase stability control of a TMD monolayer, MoTe2 monolayer, with surface adsorption of atoms and molecules. Our density functional theory (DFT) calculations reveal the potential for surface adsorption to induce a structural phase change between the competing semiconducting and metallic crystal structures of the monolayer. Further, I find that the MoxW1-xTe2 monolayer alloy composition can be tuned to achieve some degree of molecular selectivity in phase changes, providing a basis for nanoscale molecular sensing applications. I next focus on van der Waals computation for 2D materials. As an alternative to expensive standard electronic-structure approaches, I explore the potential for an electromagnetic approach to describe van der Waals interactions to provide faster computation for layered materials, including some non-pairwise effects which may be important for layered materials. Surprisingly, we find that this electromagnetic approach, based on a modified Lifshitz model, combined with DFT calculations of optical properties can provide total van der Waals interaction energies within 8-20% of the advanced electronic structure calculations for a variety of layered heterostrctures. This method potentially provides a powerful tool for studying van der Waals interactions in layered heterostructure devices. Finally, I applied our defined Lifshitz model to study surface wettability of 2D materials and their layered forms. The literature contains a wide variation of reported water contact angles for graphene, postulated to be associated with contaminations. However, a theoretical understanding of this variation has yet to be quantitatively fully explored. Here, I utilized the Lifshitz model to find that certain forms of contamination can indeed induce the large variation in reported water contact angles for layered materials. I also make predictions on layer dependence and substrate dependence of wettability.

2D Nanoscale Heterostructured Materials: Synthesis, Properties, and Applications assesses the current status and future prospects for 2D materials other than graphene (e.g., BN nanosheets, MoS2, NbSe2, WS2, etc.) that have already been contemplated for both low-end and high-end technological applications. The book offers an overview of the different synthesis techniques for 2D materials and their heterostructures, with a detailed explanation of the many potential future applications. It provides an informed overview and fundamentals properties related to the 2D Transition metal dichalcogenide materials and their heterostructures. The book helps researchers to understand the progress of this field and points the way to future research in this area. Explores synthesis techniques of newly evolved 2D materials and their heterostructures with controlled properties Offers detailed analysis of the fundamental properties (via various experimental process and simulations techniques) of 2D heterostructures materials Discusses the applications of 2D heterostructured materials in various high-performance devices

Ultrafast photonics has become an interdisciplinary topic of high international research interest because of the spectacular development of compact and efficient lasers producing optical pulses with durations in the femtosecond time domain. Present day long-haul telecommunications systems are almost entirely based on the transmission of short burst

Learn about the most recent advances in 2D materials with this comprehensive and accessible text. Providing all the necessary materials science and physics background, leading experts discuss the fundamental properties of a wide range of 2D materials, and their potential applications in electronic, optoelectronic and photonic devices. Several important classes of materials are covered, from more established ones such as graphene, hexagonal boron nitride, and transition metal dichalcogenides, to new and emerging materials such as black phosphorus, silicene, and germanene. Readers will gain an in-depth understanding of the electronic structure and optical, thermal, mechanical, vibrational, spin and plasmonic properties of each material, as well as the different techniques that can be used for their synthesis. Presenting a unified perspective on 2D materials, this is an excellent resource for graduate students, researchers and practitioners working in nanotechnology, nanoelectronics, nanophotonics, condensed matter physics, and chemistry.

Synthesis, Modelling and Characterization of 2D Materials and Their Heterostructures provides a detailed discussion on the multiscale computational approach surrounding atomic, molecular and atomic-informed continuum models. In addition to a detailed theoretical description, this book provides example problems, sample code/script, and a discussion on how theoretical analysis provides insight into optimal experimental design. Furthermore, the book addresses the growth mechanism of these 2D materials, the formation of defects, and different lattice mismatch and interlayer interactions. Sections cover direct band gap, Raman scattering, extraordinary strong light matter interaction, layer dependent photoluminescence, and other physical properties. Explains multiscale computational techniques, from atomic to continuum scale, covering different time and length scales Provides fundamental theoretical insights, example problems, sample code and exercise problems Outlines major characterization and synthesis methods for different types

of 2D materials
This book represents a significant advance in our understanding of the synthesis and properties of two-dimensional (2D) materials. The author's work breaks new ground in the understanding of a number of 2D crystals, including atomically thin transition metal dichalcogenides, graphene, and their heterostructures, that are technologically important to next-generation electronics. In addition to critical new results on the direct growth of 2D heterostructures, it also details growth mechanisms, surface science, and device applications of "epi-grade" 2D semiconductors, which are essential to low-power electronics, as well as for extending Moore's law. Most importantly, it provides an effective alternative to mechanically exfoliate 2D layers for practical applications.
2D Materials for Nanophotonics presents a detailed overview of the applications of 2D materials for nanophotonics, covering the photonic properties of a range of 2D materials including graphene, 2D phosphorene and MXenes, and discussing applications in lighting and energy storage. This comprehensive reference is ideal for readers seeking a detailed and critical analysis of how 2D materials are being used for a range of photonic and optical applications. Outlines the major photonic properties in a variety of 2D materials Demonstrates major applications in lighting and energy storage Explores the challenges of using 2D materials in photonics
Salen Metal Complexes as Catalysts for the Synthesis of Polycarbonates from Cyclic Ethers and Carbon Dioxide, by Donald J. Darensbourg.- Material Properties of Poly(Propylene Carbonates), by Gerrit. A. Luinstra and Endres Borchardt.- Poly(3-Hydroxybutyrate) from Carbon Monoxide, by Robert Reichardt and Bernhard Rieger. - Ecoflex® and Ecovio®: Biodegradable, Performance-Enabling Plastics, by K. O. Siegenthaler, A. Künkel, G. Skupin and M. Yamamoto.- Biodegradability of Poly(Vinyl Acetate) and Related Polymers, by Manfred Amann and Oliver Minge.- Recent Developments in Ring-Opening Polymerization of Lactones, by P. Lecomte and C. Jérôme.- Recent Developments in Metal-Catalyzed Ring-Opening Polymerization of Lactides and Glycolides: Preparation of Polylactides, Polyglycolide, and Poly(lactide-co-glycolide), by Saikat Dutta, Wen-Chou Hung, Bor-Hunn Huang and Chu-Chieh Lin.- Bionolle (Polybutylenesuccinate), by Yasushi Ichikawa, Tatsuya Mizukoshi.- Polyurethanes from Renewable Resources, by David A. Babb.-
This book presents advanced synthesis techniques adopted to fabricate two-dimensional (2D) transition metal dichalcogenides (TMDs) materials with its enhanced properties towards their utilization in various applications such as, energy storage devices, photovoltaics, electrocatalysis, electronic devices, photocatalysts, sensing and biomedical applications. It provides detailed coverage on everything from the synthesis and properties to the applications and future prospects of research in 2D TMD nanomaterials.
This book focuses on the progress in optoelectronic materials research and technologies, presenting reviews and original works on the theory, fabrication, characterization, and applications of optoelectronic materials. The chapters discuss preparation and properties of several optoelectronic materials, such as ZnO, SnO2, Zn1-XSnXO, BaTiO3, GaAs, GaP, ZnSe, and NaAlSi. The structural, optical, vibrational, and magnetic properties are discussed, in addition to transport and phase transformations.
The unique electrical and optical properties of two-dimensional (2D) materials has spurred intense research interest towards development of nanoelectronic devices utilizing these novel materials. The atomically thin form of 2D materials translates to excellent electrostatic gate control even at nanoscale channel length dimensions, near-ideal two-dimensional carrier behavior, and perhaps conventional and novel devices applications. Monolayer transition metal dichalcogenides (TMDs) are novel, gapped 2D materials. Toward device applications, I consider MoS2 layers on dielectrics, in particular in this work, the effect of vacancies on the electronic structure. In density-functional-theory (DFT) simulations, the effects of near-interface oxygen vacancies in the oxide slab, and Mo or S vacancies in the MoS2 layer are considered. Band structures and atom-projected densities of states for each system and with differing oxide terminations were calculated, as well as those for the defect-free MoS2-dielectrics system and for isolated dielectric layers for reference. Among the results, I find that with O-vacancies, both the HfO2-MoS2 and the Al2O3-MoS2 systems appear metallic due to doping of the oxide slab followed by electron transfer into the MoS2, in manner analogous to modulation doping. The n-type doping of monolayer MoS2 by high-k oxides with O-vacancies is confirmed through collaborative experimental work in which back-gated monolayer MoS2 FETs encapsulated by oxygen deficient high-k oxides have been characterized. Van der Waal's heterostructures allow for novel devices such as two-dimensional-to-two-dimensional tunnel devices, exemplified by interlayer tunnel FETs. These devices employ channel/tunnel-barrier/channel geometries. However, during layer-by-layer exfoliation of these multi-layer materials, rotational misalignment is the norm and may substantially affect device characteristics. In this work, by using density functional theory methods, I consider a reduction in tunneling due to weakened coupling across the rotationally misaligned interface between the channel layers and the tunnel barrier. As a prototypical system, I simulate the effects of rotational misalignment of the tunnel barrier layer between aligned channel layers in a graphene/hBN/graphene system. Rotational misalignment between the channel layers and the tunnel barrier in this van der Waal's heterostructure can significantly reduce coupling between the channels by reducing, specifically, coupling across the interface between the channels and the tunnel barrier. This weakened coupling in graphene/hBN/graphene with hBN misalignment may be relevant to all such van der Waal's heterostructures. TMDs are viable alternatives to graphene and hBN as channel and tunnel barrier layers, respectively, for improved performance in interlayer tunnel FET device structures. In particular, I used DFT simulations to study the bilayer-graphene/WSe2/bilayer-graphene heterostructure as well as single and multilayer ReS2-layer systems. Significant roadblocks to the widespread use of TMDs for nanoelectronic devices are the large contact resistance and absence of reliable doping techniques. Hence, I studied substitutional doping of, and evaluated various metal contacts to MoS2 by computing the density of states for the systems. Metal contacts that pin the Fermi

level within the desired band are optimal for device applications. My simulation results suggest that monolayer (ML) MoS2 can be doped n-type or p-type by substituting for an S atom in the supercell with a group-17 Cl atom or a group-15 P atom, respectively. My simulations also suggest that Sc and Ti would serve as excellent contacts to n-type ML MoS2 due to the strong bonding and large number of states near the Fermi level. But the theoretical expectations are tempered by the material characteristics, i.e., the extremely reactive nature of Sc and the oxidation prone nature of Ti atoms. I also studied commonly used Ag and Au metal contacts to ML MoS2, which exhibited medium strength bonding to MoS2 and an apparent pinning of the Fermi level nearer to the nominal MoS2 conduction band edge

2D Materials and Van der Waals HeterostructuresPhysics and ApplicationsMDPI

2D Materials contains the latest information on the current frontier of nanotechnology, the thinnest form of materials to ever occur in nature. A little over 10 years ago, this was a completely unknown area, not thought to exist. However, since then, graphene has been isolated and acclaimed, and a whole other class of atomically thin materials, dominated by surface effects and showing completely unexpected and extraordinary properties has been created. This book is ideal for a variety of readers, including those seeking a high-level overview or a very detailed and critical analysis. No nanotechnologist can currently overlook this new class of materials. Presents one of the first detailed books on this subject of nanotechnology Contains contributions from a great line-up of authoritative contributors that bring together theory and experiments Ideal for a variety of readers, including those seeking a high-level overview or a very detailed and critical analysis

Inorganic 2D nanomaterials, or inorganic graphene analogues, are gaining great attention due to their unique properties and potential energy applications. They contain ultrathin nanosheet morphology with one-dimensional confinement, but unlike pure carbon graphene, inorganic two-dimensional nanomaterials have a more abundant elemental composition and can form different crystallographic structures. These properties contribute to their unique chemical reaction activity, tunable physical properties and facilitate applications in the field of energy conversion and storage. Inorganic Two-dimensional Nanomaterials details the development of the nanostructures from computational simulation and theoretical understanding to their synthesis and characterization. Individual chapters then cover different applications of the materials as electrocatalysts, flexible supercapicitors, flexible lithium ion batteries and thermoelectrical devices. The book provides a comprehensive overview of the field for researchers working in the areas of materials chemistry, physics, energy and catalysis.

There are only a few discoveries and new technologies in materials science that have the potential to dramatically alter and revolutionize our material world. Discovery of two-dimensional (2D) materials, the thinnest form of materials to ever occur in nature, is one of them. After isolation of graphene from graphite in 2004, a whole other class of atomically thin materials, dominated by surface effects and showing completely unexpected and extraordinary properties, has been created. This book provides a comprehensive view and state-of-the-art knowledge about 2D materials such as graphene, hexagonal boron nitride (h-BN), transition metal dichalcogenides (TMD) and so on. It consists of 11 chapters contributed by a team of experts in this exciting field and provides latest synthesis techniques of 2D materials, characterization and their potential applications in energy conservation, electronics, optoelectronics and biotechnology.

This book shows the electronic, optical and lattice-vibration properties of the two-dimensional materials which are revealed by the Raman spectroscopy. It consists of eleven chapters covering various Raman spectroscopy techniques (ultralow-frequency, resonant Raman spectroscopy, Raman imaging), different kinds of two-dimensional materials (in-plane isotropy and anisotropy materials, van der Waals heterostructures) and their physical properties (double-resonant theory, surface and interface effect). The topics include the theory origin, experimental phenomenon and advanced techniques in this area. This book is interesting and useful to a wide readership in various fields of condensed matter physics, materials science and engineering.

Graduate textbook and sourcebook on surface and thin film processes, with links to the World Wide Web.

This book presents the first established experimental results of an emergent field: 2-dimensional materials as platforms for quantum technologies, specifically through the optics of quantum-confined excitons. It also provides an extensive review of the literature from a number of disciplines that informed the research, and introduces the materials of focus – 2d Transition Metal Dichalcogenides (2d-TMDs) – in detail, discussing electronic and chemical structure, excitonic behaviour and response to strain. This is followed by a brief overview of quantum information technologies, including concepts such as single-photon sources and quantum networks. The methods chapter addresses quantum optics techniques and 2d-material processing, while the results section shows the development of a method to deterministically create quantum dots (QDs) in the 2d-TMDs, which can trap single-excitons; the fabrication of atomically thin quantum light-emitting diodes to induce all-electrical single-photon emission from the QDs, and lastly, the use of devices to controllably trap single-spins in the QDs –the first step towards their use as optically-addressable matter qubits.

2D Semiconductor Materials and Devices reviews the basic science and state-of-art technology of 2D semiconductor materials and devices. Chapters discuss the basic structure and properties of 2D semiconductor materials, including both elemental (silicene, phosphorene) and compound semiconductors (transition metal dichalcogenide), the current growth and characterization methods of these 2D materials, state-of-the-art devices, and current and potential applications. Reviews a broad range of emerging 2D electronic materials beyond graphene, including silicene, phosphorene and compound semiconductors Provides an in-depth review of material properties, growth and characterization aspects—topics that could enable applications Features contributions from the leading experts in the field

2D Materials for Photonic and Optoelectronic Applications introduces readers to two-dimensional materials and their properties (optical, electronic, spin and plasmonic), various methods of synthesis, and possible applications, with a strong focus on novel findings and technological challenges. The two-dimensional materials reviewed include hexagonal boron nitride, silicene, germanene, topological insulators, transition metal dichalcogenides, black phosphorous and other novel materials. This book will be ideal for students and researchers in materials science, photonics, electronics, nanotechnology and condensed matter physics and chemistry, providing background for both junior investigators and timely reviews for seasoned researchers. Provides an in-depth look at boron nitride, silicene, germanene, topological insulators, transition metal dichalcogenides, and more Reviews key applications for photonics and optoelectronics, including photodetectors, optical signal processing, light-emitting diodes and photovoltaics Addresses key technological challenges for the realization of optoelectronic applications and comments on future solutions

This book brings together innovative methodologies and strategies adopted in the research and developments of Advanced 2D Materials. Well-known worldwide researchers deliberate subjects on (1) Synthesis, characterizations, modeling and properties, (2) State-of-the-art design and (3) innovative uses of 2D materials including: Two-dimensional layered gallium selenide Synthesis of 2D boron nitride nanosheets The effects of substrates on 2-D crystals Electrical conductivity and reflectivity of models of some 2D materials Graphene derivatives in semicrystalline polymer composites Graphene oxide based multifunctional composites Covalent and non-covalent polymer grafting of graphene oxide Graphene-semiconductor hybrid photocatalysts for solar fuels Graphene based sensors Graphene composites from bench to clinic Photocatalytic ZnO-graphene hybrids Hydroxyapatite-graphene bioceramics in orthopaedic applications

In this thesis, I present experimental results on coherent electron phenomena in layered two-dimensional materials: single layer graphene and van der Waals coupled 2D TiSe2. Graphene is a two-dimensional single-atom thick sheet of carbon atoms first derived from bulk graphite by the mechanical exfolia- tion technique in 2004. Low-energy charge carriers in graphene behave like massless Dirac fermions, and their density can be easily tuned between electron-rich and hole-rich quasiparticles with electrostatic gating techniques. The sharp interfaces between regions of different carrier densities form barriers with selective transmission, making them behave as partially reflecting mirrors. When two of these interfaces are set at a separation distance within the phase coherence length of the carriers, they form an electronic version of a Fabry-Perot cavity. I present measurements and analysis of multiple Fabry-Perot modes in graphene with parallel electrodes spaced a few hundred nanometers apart. Transition metal dichalcogenide (TMD) TiSe2 is part of the family of materials that coined the term "materials beyond graphene". It contains van der Waals coupled trilayer stacks of Se-Ti-Se. Many TMD materials exhibit a host of interesting correlated electronic phases. In particular, TiSe2 exhibits chiral charge density waves (CDW) below TCDW ~ 200 K. Upon doping with copper, the CDW state gets suppressed with Cu concentration, and CuxTiSe2 becomes superconducting with critical temperature of Tc = 4.15 K. There is still much debate over the mechanisms governing the coexistence of the two correlated electronic phases - CDW and superconductivity. I will present some of the first conductance spectroscopy measurements of proximity coupled superconductor-CDW systems. Measurements reveal a proximity-induced critical current at the Nb-TiSe2 interfaces, suggesting pair correlations in the pure TiSe2. The results indicate that superconducting order is present concurrently with CDW in pure TiSe2, contradicting the notion of a competition between two correlated electron states.

AIDS and the Law provides comprehensive coverage of the complex legal issues, as well as the underlying medical and scientific issues, surrounding the HIV epidemic. Covering a broad range of legal fields from employment to health care to housing and privacy rights, this essential resource provides thorough up-to-date coverage of a rapidly changing area of law. The Fifth Edition of AIDS and the Law has been updated to include: Updates regarding medical advancements in treating and preventing HIV, including pre-exposure prophylaxis (PrEP) Analysis of the FDA's revised recommendations for blood donations from men who have sex with men Synthesized and streamlined analysis of the Americans with Disabilities Act and the ADA Amendments Act of 2008 Comprehensive discussion of housing protections for people living with HIV Updates regarding the National HIV/AIDS Strategy, including the revised Strategy released in 2015 Important developments regarding the U.S. government's treatment of HIV-positive immigrants Discussion of the Affordable Care Act's anti-discrimination provisions for people living with HIV Overview of new international and foreign protections for people living with HIV Information on navigating the many public benefit regimes potentially available to people living with HIV Detailed discussion regarding protections for prisoners living with HIV, including new case law forbidding segregation

This book is a printed edition of the Special Issue "Integration of 2D Materials for Electronics Applications" that was published in Crystals

All set to become the standard reference on the topic, this book covers the most important procedures for chemical functionalization, making it an indispensable resource for all chemists, physicists, materials scientists and engineers entering or already working in the field. Expert authors share their knowledge on a wide range of different functional groups, including organic functional groups, hydrogen, halogen, nanoparticles and polymers.

Since the great success of graphene, atomically thin-layered nanomaterials, called two dimensional (2D) materials, have attracted tremendous attention due to their extraordinary physical properties. Specifically, van der Waals heterostructured architectures based on a few 2D materials, named atomic-scale Lego, have been proposed as unprecedented platforms for the implementation of versatile devices with a completely novel function or extremely high-performance, shifting the research paradigm in materials science and engineering. Thus, diverse 2D materials beyond existing bulk materials have been widely studied for promising electronic, optoelectronic, mechanical, and thermoelectric applications. Especially, this Special Issue included the recent advances in the unique preparation methods such as exfoliation-based synthesis and vacuum-based deposition of diverse 2D materials and also their device applications based on interesting physical properties. Specifically, this Editorial consists of the following two parts: Preparation methods of 2D materials and Properties of 2D materials

Fundamentals and Applications of Supercapacitor 2D Materials covers different aspects of supercapacitor 2D materials, including their important properties, synthesis, and recent developments in supercapacitor applications of engineered 2D materials. In addition, theoretical investigations and various types of supercapacitors based on 2D materials such as symmetric, asymmetric, flexible, and micro-supercapacitors are covered. This book is a useful resource for research scientists, engineers, and students in the fields of supercapacitors, 2D nanomaterials, and energy storage devices. Due to their sub-nanometer thickness, 2D materials have a high packing density, which is suitable for the fabrication of highly-packed energy supplier/storage devices with enhanced energy and power density. The flexibility of 2D materials, and their good mechanical properties and high packing densities, make them suitable for the development of thin, flexible, and wearable devices. Explores recent developments and looks at the importance of 2D materials in energy storage technologies Presents both the theoretical and DFT related studies Discusses the impact on performance of various operating conditions Includes a brief overview of the applications of supercapacitors in various industries, including aerospace, defense, biomedical, environmental, energy, and automotive

Spintronic 2D Materials: Fundamentals and Applications provides an overview of the fundamental theory of 2D electronic systems that includes a selection of the most intensively investigated 2D materials. The book tells the story of 2D spintronics in a systematic and comprehensive way, providing the growing community of spintronics researchers with a key reference. Part One addresses the fundamental theoretical aspects of 2D materials and spin transport, while Parts Two through Four explore 2D material systems, including graphene, topological insulators, and transition metal dichalcogenides. Each section discusses properties, key issues and recent developments. In addition, the material growth method (from lab to mass production), device fabrication and characterization techniques are included throughout the book. Discusses the fundamentals and applications of spintronics of 2D materials, such as graphene, topological insulators and transition metal dichalcogenides Includes an in-depth look at each materials system, from material growth, device fabrication and characterization techniques Presents the latest solutions on key challenges, such as the spin lifetime of 2D materials, spin-injection efficiency, the potential proximity effects, and much more

This book focuses on angle-resolved photoemission spectroscopy studies on novel interfacial phenomena in three typical two-dimensional material heterostructures: graphene/h-BN, twisted bilayer graphene, and topological insulator/high-temperature superconductors. Since the discovery of graphene, two-dimensional materials have proven to be quite a large “family”. As an alternative to searching for other family members with distinct properties, the combination of two-dimensional (2D) materials to construct heterostructures offers a new platform for achieving new quantum phenomena, exploring new physics, and designing new quantum devices. By stacking different 2D materials together and utilizing interfacial periodical potential and order-parameter coupling, the resulting heterostructure’s electronic properties can be tuned to achieve novel properties distinct from those of its constituent materials. This book offers a valuable reference guide for all researchers and students working in the area of condensed matter physics and materials science.

Graphene is probably the most fascinating material discovered in this century. A group of 2D materials can be called graphene derivatives, and these have attracted tremendous interest. This includes materials that are one or a few atoms thick. They have outstanding optical/electrical properties, and, most importantly, they are flat and thin—they can be processed with existing semiconductor technologies. Therefore, they have great potential in nanoelectronics and optoelectronics, playing a revolutionary role in these fields via their integration with other bulk materials. Of course, there are still challenges, such as large-scale production, as well as the mechanical transfer of these atomically thin sheets. These are the fields where scientists are now actively doing research. In this book, some leading scientists in the area share their most recent results on the material growth, device physics/processing, and system integration of 2D materials and devices. This book can serve as a starting point for young students to get familiar with the field, and should also be valuable to established device physicists and engineers who would like to explore the potential applications of 2D materials in electronics.