Dielectric Polymer Nanocomposites

Dielectric Polymer NanocompositesBroadband Dielectric SpectroscopyHandbook of Polymer Nanocomposites for Industrial ApplicationsPhysical Properties and Applications of Polymer NanocompositesGraphene-Based Polymer Nanocomposites in ElectronicsModern Polymer SpectroscopyPolymers and Multicomponent Polymeric SystemsAdvanced Dielectric Materials for Electrostatic CapacitorsRecent Trends in Materials and DevicesFunctional PolymersElectrical Conductivity in Polymer-Based Composites3D and 4D Printing of Polymer Nanocomposite MaterialsTailoring of Nanocomposite DielectricsMultifunctional Polymer NanocompositesEnhancing Electrical Energy Storage Capability of Dielectric Polymer Nanocomposites Via the Room Temperature Coulomb Blockade Effect of Ultra-small Platinum Nanoparticles1Conducting Polymer HybridsOptimum Composite StructuresAdvanced NanodielectricsThe Application of Dielectric and Electrocaloric Cooling Devices Based on Dielectric PolymersSpectroscopy of Polymer NanocompositesPolymer-Based Multifunctional Nanocomposites and Their ApplicationsPolymer-based Nanocomposites for Energy and Environmental ApplicationsPolymer Nanocomposites for DielectricsGraphene-Based Polymer Nanocomposites in ElectronicsPolymer NanocompositesFundamentals, Properties, and Applications of Polymer NanocompositesPolymer NanocompositesNanocomposite Science and TechnologyInterface / Interphase in Polymer NanocompositesCharacterization Techniques for Polymer NanocompositesAI in Manufacturing and Green TechnologySustainable Polymer Composites and NanocompositesPolymer NanocompositesPolymer/layered Silicate NanocompositesAdvances in Polymer NanocompositesPolymer DielectricsDielectric Polymer Materials for High-Density Energy StoragePolymer-Engineered Nanostructures for Advanced Energy ApplicationsPolymer Nanocomposites in Biomedical EngineeringProperties and Applications of Polymer Nanocomposites

Dielectric Polymer Nanocomposites

Discusses polymer nanocomposites composed of a family of polymeric materials whose properties are capable of being tailored to meet specific applications.

Broadband Dielectric Spectroscopy

This book presents a thorough discussion of the physics, biology, chemistry and medicinal science behind a new and important area of materials science and engineering: polymer nanocomposites. The tremendous opportunities of polymer nanocomposites in the biomedical field arise from their multitude of applications and their ability to satisfy the vastly different functional requirements for each of these applications. In the biomedical field, a polymer nanocomposite system must meet certain design and functional criteria, including biocompatibility, biodegradability, mechanical properties, and, in some cases, aesthetic demands. The content of this book builds on what has been learnt in elementary courses about synthesising polymers, different nanoparticles, polymer composites, biomedical requirements, uses of polymer nanocomposites in medicine as well as medical devices and the major mechanisms involved during each application. The impact of hybrid nanofillers and synergistic composite mixtures which are used

extensively or show promising outcomes in the biomedical field are also discussed. These novel materials vary from inorganic/ceramic-reinforced nanocomposites for mechanical property improvement to peptide-based nanomaterials, with the chemistry designed to render the entire material biocompatible.

Handbook of Polymer Nanocomposites for Industrial Applications

Polymers have been used as dielectric materials owing to their light weight, great flexibility, and processability as well as high insulation properties. To enhance their performance for various desired dielectric applications, fabrication of polymeric nanocomposites is believed to be one of the most effective approaches. By controlling the nanomaterial dispersion and interfacial structures with the polymer matrices in nanocomposites, dielectric properties can be tailored for specific applications. This book reviews representative polymer nanocomposite systems, focusing on the roles of nanodispersion, interfacial structures, and properties of polymer matrix materials in the dielectric properties and energy storage performance. The book reviews various dielectric relaxation models applicable to the analysis of polymer nanocomposites. It compiles the recent progress in new dielectric polymer nanocomposites based on biomaterials and hybrid nanomaterial systems for advanced dielectric applications.

Physical Properties and Applications of Polymer Nanocomposites

With its focus on the characterization of nanocomposites using such techniques as x-ray diffraction and spectrometry, light and electron microscopy, thermogravimetric analysis, as well as nuclear magnetic resonance and mass spectroscopy, this book helps to correctly interpret the recorded data. Each chapter introduces a particular characterization method, along with its foundations, and makes the user aware of its benefits, but also of its drawbacks. As a result, the reader will be able to reliably predict the microstructure of the synthesized polymer nanocomposite and its thermal and mechanical properties, and so assess its suitability for a particular application. Belongs on the shelf of every product engineer.

Graphene-Based Polymer Nanocomposites in Electronics

In recent years, nanocomposites have captured and held the attention and imagination of scientists and engineers alike. Based on the simple premise that by using a wide range of building blocks with dimensions in the nanosize region, it is possible to design and create new materials with unprecedented flexibility and improvements in their physical properties. This book contains the essence of this emerging technology, the underlying science and motivation behind the design of these structures and the future, particularly from the perspective of applications. It is intended to be a reference handbook for future scientists and hence carries the basic science and the fundamental engineering principles that lead to the fabrication and property evaluation of nanocomposite materials in different areas of materials science and technology.

Modern Polymer Spectroscopy

This book focuses on the fundamental principles and recent progress in the field of electrical and thermal properties of polymer nanocomposites. The physical and chemical natures determining the electrical and thermal properties of polymer nanocomposites are discussed in detail. The authors describe the range of traditional and emerging polymer nanocomposites from nanoparticle and polymer composites to novel nanostructure based polymer nanocomposites. They include novel properties and potential applications, such as high-k, low-k, high thermal conductivity, antistatic, high voltage insulation, electric stress control, and thermal energy conversion among others.

Polymers and Multicomponent Polymeric Systems

The novel properties of multifunctional polymer nanocomposites make them useful for a broad range of applications in fields as diverse as space exploration, bioengineering, car manufacturing, and organic solar cell development, just to name a few. Presenting an overview of polymer nanocomposites, how they compare with traditional composites, and th

Advanced Dielectric Materials for Electrostatic Capacitors

This book illustrates interfacial properties, preparation, characterization, devices, and applications from the standpoint of nano-interfacial tailoring. Since the primary focus of the book is on the use of nanocomposite dielectrics in electrical applications, chapters are devoted to directly relevant topics, such as surface and bulk breakdown processes. However, the mechanisms that underpin such behavior are not unique. Therefore, the book also addresses related topics that range from the chemistry of polymer and nanocomposite degradation to the simulation of charge transport dynamics in disordered materials, thereby presenting a multi- and interdisciplinary approach to the area. It will serve as a practical handbook or graduate textbook and is supplemented by ample number of illustrations, case studies, practical examples, and historical perspectives.

Recent Trends in Materials and Devices

This reference work provides a comprehensive and authoritative overview of functional polymers and polymeric materials, ranging from their synthesis and characterization, to properties, actual applications and an outlook on future perspectives. Including over 30 comprehensive review chapters, all written by leading international experts, this reference is also a sound introduction to this exciting field. The book is carefully edited by an international team of experts in the field, ensuring complete coverage of the relevant topics and concise representation. Functional polymers and smart polymeric materials play a decisive role for new innovations in all areas where new materials are needed. Optoelectronics, catalysis, biomaterials, medicine, building materials, water treatment, coatings, and many more applications rely on functional polymers. This work is a major reference for researchers, scientists, and practitioners working in any of these fields, or entering this vibrant research area. Key topics of this

reference work include: Polymerization methods and polymer synthesis Characterization and properties of new functional polymers and smart materials Functional polymer composites and blends Applications of functional polymers and smart materials: for electro-optics and optoelectronics, in biology and in medical research, as coatings and adhesives, for gas sensing, in functional membranes for separation or proton conduction and many more

Functional Polymers

The book gives the reader an overview on electrical properties and applications such as converter transformer, transistor, and energy storage. Besides, this book also presents some recent researches on typical polymer material such as silicon rubber and LDPE, which may provide some clues of advanced polymer properties for both engineers and researches. The author has been a professor at the Department of Electrical Engineering, School of Electrical Engineering and Automation, Tianjin University, China, since 2002. He has been active in polymer insulation research since the 1990s. He is a member of IEEJ, senior member of CSEE, member at several WG in CIGRE, and associate editor of the IEEE Transactions on Dielectrics and Electrical Insulation.

Electrical Conductivity in Polymer-Based Composites

Polymer nanocomposites are polymer matrices reinforced with nano-scale fillers. This new class of composite materials has shown improved mechanical and physical properties. The latter include enhanced optical, electrical and dielectric properties. This important book begins by examining the characteristics of the main types of polymer nanocomposites, then reviews their diverse applications. Part one focuses on polymer/nanoparticle composites, their synthesis, optical properties and electrical conductivity. Part two describes the electrical, dielectric and thermal behaviour of polymer/nanoplatelet composites, whilst polymer/nanotube composites are the subject of Part three. The processing and industrial applications of these nanocomposite materials are discussed in Part four, including uses in fuel cells, bioimaging and sensors as well as the manufacture and applications of electrospun polymer nanocomposite fibers, nanostructured transition metal oxides, clay nanofiller/epoxy nanocomposites, hybrid epoxy-silica-rubber nanocomposites and other rubber-based nanocomposites. Polymer nanocomposites: Physical properties and applications is a valuable reference tool for both the research community and industry professionals wanting to learn about the these materials and their applications in such areas as fuel cell, sensor and biomedical technology. Examines the characteristics of the main types of polymer nanocomposites and reviews their diverse applications Comprehensively assesses polymer/nanoparticle composites exploring experimental techniques and data associated with the conductivity and dielectric characterization A specific section on polymer/nanotube composites features electrical and dielectric behaviour of polymer/carbon nanotube composites

3D and 4D Printing of Polymer Nanocomposite Materials

This book presents a comprehensive survey about conducting polymers and their

hybrids with different materials. It highlights the topics pertinent to research and development in academia and in the industry. The book thus discusses the preparation and characterization of these materials, as well as materials properties and their processing. The current challenges in the field are addressed, and an outline on new and even futuristic approaches is given. “Conducting Polymer Hybrids” is concerned with a fascinating class of materials with the promise for wide-ranging applications, including energy generation and storage, supercapacitors, electronics, display technologies, sensing, environmental and biomedical applications. The book covers a large variety of systems: one-, two-, and three-dimenstional composites and hybrids, mixed at micro- and nanolevel.

Tailoring of Nanocomposite Dielectrics

3D and 4D Printing of Polymer Nanocomposite Materials: Processing, Applications, and Challenges covers advanced 3D and 4D printing processes and the latest developments in novel polymer-based printing materials, thus enabling the reader to understand and benefit from the advantages of this groundbreaking technology. The book presents processes, materials selection, and printability issues, along with sections on the preparation of polymer composite materials for 3D and 4D printing. Across the book, advanced printing techniques are covered and discussed thoroughly, including fused deposition modeling (FDM), selective laser sintering (SLS), selective laser melting (SLM), electron beam melting (EBM), inkjet 3D printing (3DP), stereolithography (SLA), and 3D plotting. Finally, major applications areas are discussed, including electronic, aerospace, construction and biomedical applications, with detailed information on the design, fabrication and processing methods required in each case. Provides a thorough, clear understanding of polymer preparation techniques and 3D and 4D printing processes, with a view to specific applications Examines synthesis, formation methodology, the dispersion of fillers, characterization, properties, and performance of polymer nanocomposites Explores the possibilities of 4D printing, covering the usage of stimuli responsive hydrogels and shape memory polymers

Multifunctional Polymer Nanocomposites

In recent years, multicomponent polymers have generated much interest due to their excellent properties, unique morphology and high-end applications. Book focusses on thermal, thermo-mechanical and dielectric analysis of polymers and multicomponent polymeric systems like blends, interpenetrating polymeric networks (IPNs), gels, polymer composites, nanocomposites. Through these analyses, it provides an insight into the stability of polymer systems as a function of time, processing and usage. Aimed at polymer chemists, physicists and engineers, it also covers ASTM /ISO and other standards of various measurement techniques for systematic analysis in materials science.

Enhancing Electrical Energy Storage Capability of Dielectric Polymer Nanocomposites Via the Room Temperature Coulomb Blockade Effect of Ultra-small Platinum Nanoparticles1

Polymer nanocomposites are polymer matrices reinforced with nano-scale fillers.

This new class of composite materials has shown enhanced optical, electrical and dielectric properties. This important book begins by examining the characteristics of the main types of polymer nanocomposites and then reviews their diverse applications. Part one focuses on polymer/nanoparticle composites, their synthesis, optical properties and electrical conductivity. Part two describes the electrical, dielectric and thermal behaviour of polymer/nanoplatelet composites, whilst polymer/nanotube composites are the subject of Part three. The processing and industrial applications of these nanocomposite materials are discussed in Part four, including uses in fuel cells, bioimaging and sensors as well as the manufacture and applications of electrospun polymer nanocomposite fibers, nanostructured transition metal oxides, clay nanofiller/epoxy nanocomposites, hybrid epoxy-silica-rubber nanocomposites and other rubber-based nanocomposites. Polymer nanocomposites: physical properties and applications is a valuable reference tool for both the research community and industry professionals wanting to learn about these materials and their applications in such areas as fuel cell, sensor and biomedical technology. Gives a comprehensive review of polymer nanocomposites and their properties A standard reference on this area Written by distinguished editors and a international team of authors

Conducting Polymer Hybrids

Spectroscopy of Polymer Nanocomposites covers all aspects of the spectroscopic characterization of polymer nanocomposites. More than 25 spectroscopy characterization techniques – almost all used in materials science – are treated in the book, with discussion of their potentialities and limitations. By comparing the techniques with each other and presenting the techniques together with their specific application areas, the book provides scientists and engineers the information needed for solving specific problems and choosing the right technique for analyzing the material structure. From this, the dispersion structure of fillers, property relations and filler-polymer interactions can be determined, and, ultimately, the right materials can be chosen for the right applications. Besides the techniques and structure-property relations, aspects covered include: phase segregation of filler particles, filler agglomeration and deagglomeration, filler dispersion, filler-polymer interactions, surfaces and interfaces. The book also examines recent developments, as well as unresolved issues and new challenges, in the characterization of surfaces and interfaces in polymer nanocomposites. This handpicked selection of topics, and the combined expertise of contributors from industry, academia, government and private research organizations across the globe, make this survey an outstanding reference source for anyone involved in the field of polymer nanocomposites in academia or industry. Provides comprehensive coverage of spectroscopy techniques for analyzing polymer nanocomposites Enables researchers and engineers to choose the right technique and make better materials decisions in research and a range of industries Presents the fundamentals, information on structure-property relations, and all other aspects relevant for understanding spectroscopic analyses of nanoreinforced polymers and their applications

Optimum Composite Structures

This book covers graphene reinforced polymers, which are useful in electronic

applications, including electrically conductive thermoplastics composites, thermosets and elastomers. It systematically introduces the reader to fundamental aspects and leads over to actual applications, such as sensor fabrication, electromagnetic interference shielding, optoelectronics, superconductivity, or memory chips. The book also describes dielectric and thermal behaviour of graphene polymer composites - properties which are essential to consider for the fabrication and production of these new electronic materials. The contributions in this book critically discuss the actual questions in the development and applications of graphene polymer composites. It will thus appeal to chemists, physicists, materials scientists as well as nano technologists, who are interested in the properties of graphene polymer composites.

Advanced Nanodielectrics

The subject of optimum composite structures is a rapidly evolving field and intensive research and development have taken place in the last few decades. Therefore, this book aims to provide an up-to-date comprehensive overview of the current status in this field to the research community. The contributing authors combine structural analysis, design and optimization basis of composites with a description of the implemented mathematical approaches. Within this framework, each author has dealt with the individual subject as he/she thought appropriate. Each chapter offers detailed information on the related subject of its research with the main objectives of the works carried out as well as providing a comprehensive list of references that should provide a rich platform of research to the field of optimum composite structures.

The Application of Dielectric and Electrocaloric Cooling Devices Based on Dielectric Polymers

This book presents the proceedings of the International Conference on Recent Trends in Materials and Devices, which was conceived as a major contribution to large-scale efforts to foster Indian research and development in the field in close collaboration with the community of non-resident Indian researchers from all over the world. The research articles collected in this volume - selected from among the submissions for their intrinsic quality and originality, as well as for their potential value for further collaborations - document and report on a wide range of recent and significant results for various applications and scientific developments in the areas of Materials and Devices. The technical sessions covered include photovoltaics and energy storage, semiconductor materials and devices, sensors, smart and polymeric materials, optoelectronics, nanotechnology and nanomaterials, MEMS and NEMS, as well as emerging technologies.

Spectroscopy of Polymer Nanocomposites

Dielectric Polymer Nanocomposites provides the first in-depth discussion of nano-dielectrics, an emerging and fast moving topic in electrical insulation. The text begins with an overview of the background, principles and promise of nanodielectrics, followed by a discussion of the processing of nanocomposites and then proceeds with special considerations of clay based processes, mechanical,

thermal and electric properties and surface properties as well as erosion resistance. Carbon nanotubes are discussed as a means of creation of non linear conductivity, the text concludes with a industrial applications perspective.

Polymer-Based Multifunctional Nanocomposites and Their Applications

Handbook of Polymer Nanocomposites for Industrial Applications summarizes the properties of polymer nanocomposites, discusses their industrial scale fabrication methods, and presents their applications for various industrial sectors at both experimental and theoretical models scales. The book also addresses existing challenges for the use of polymer nanocomposites in major industrial sectors. Overall, the aim of this book is to summarize the recent advancements in the use of PNCs in a variety of industry sectors. Particular attention is paid to those approaches that enable green and sustainable industrial developments. The legal, economical and toxicity aspects of polymer nanocomposite are also presented in detail. Comprehensively explores how polymer nanocomposites are being used to create more efficient products and devices in a variety of industry sectors Explores the environmental, legal, health and safety issues of using polymer nanocomposites in an industrial context Develops a roadmap to the wider commercial utilization of polymer nanocomposites Emphasizes the use of polymer nanocomposites in green and sustainable technologies

Polymer-based Nanocomposites for Energy and Environmental Applications

The addition of nanoparticles to polymer composites has led to a new generation of composite materials with enhanced and novel properties. Advances in polymer nanocomposites reviews the main types of polymer nanocomposites and their applications. Part one reviews types of polymer nanocomposites according to fillers. Processing of carbon nanotube-based nanocomposites, layered double hydroxides (LDHs) and cellulose nanoparticles as functional fillers and reinforcement are discussed, alongside calcium carbonate and metal-polymer nanocomposites. Part two focuses on types of polymer nanocomposites according to matrix polymer, with polyolefin-based, (PVC)-based, nylon-based, (PET)-based and thermoplastic polyurethane (TPU)-based polymer nanocomposites discussed. Soft, gel and biodegradable polymer nanocomposites are also considered. Part three goes on to investigate key applications, including fuel cells, aerospace applications, optical applications, coatings and flame-retardant polymer nanocomposites. With its distinguished editor and international team of expert contributors, Advances in polymer nanocomposites is an essential guide for professionals and academics involved in all aspects of the design, development and application of polymer nanocomposites. Reviews the main types of polymer nanocomposites and their applications Discusses processing of carbon nanotube-based nanocomposites, layered double hydroxides (LDHs) and cellulose nanoparticles as functional fillers and reinforcement Discusses polyolefin-based, (PVC)-based, nylon-based, (PET)-based and thermoplastic polyurethane (TPU)-based polymer nanocomposites

Polymer Nanocomposites for Dielectrics

This book focuses on the fundamental principles and recent progress in the field of electrical and thermal properties of polymer nanocomposites. The physical and chemical natures determining the electrical and thermal properties of polymer nanocomposites are discussed in detail. The authors describe the range of traditional and emerging polymer nanocomposites from nanoparticle and polymer composites to novel nanostructure based polymer nanocomposites. They include novel properties and potential applications, such as high-k, low-k, high thermal conductivity, antistatic, high voltage insulation, electric stress control, and thermal energy conversion among others.

Graphene-Based Polymer Nanocomposites in Electronics

This book focuses on environmental sustainability by employing elements of engineering and green computing through modern educational concepts and solutions. It visualizes the potential of artificial intelligence, enhanced by business activities and strategies for rapid implementation, in manufacturing and green technology. This book covers utilization of renewable resources and implementation of the latest energy-generation technologies. It discusses how to save natural resources from depletion and illustrates facilitation of green technology in industry through usage of advanced materials. The book also covers environmental sustainability and current trends in manufacturing. The book provides the basic concepts of green technology, along with the technology aspects, for researchers, faculty, and students.

Polymer Nanocomposites

This book provides an overview of key dielectric materials for capacitor technology. It covers preparation and characterization of state-of-the art dielectric materials including ceramics, polymers and polymer nanocomposites, for popular applications including energy storage, microwave communication and multi-layer ceramic capacitors.

Fundamentals, Properties, and Applications of Polymer Nanocomposites

Polymer-Based Nanocomposites for Energy and Environmental Applications provides a comprehensive and updated review of major innovations in the field of polymer-based nanocomposites for energy and environmental applications. It covers properties and applications, including the synthesis of polymer based nanocomposites from different sources and tactics on the efficacy and major challenges associated with successful scale-up fabrication. The chapters provide cutting-edge, up-to-date research findings on the use of polymer based nanocomposites in energy and environmental applications, while also detailing how to achieve material’s characteristics and significant enhancements in physical, chemical, mechanical and thermal properties. It is an essential reference for future research in polymer based nanocomposites as topics such as sustainable, recyclable and eco-friendly methods for highly innovative and applied materials

are current topics of importance. Covers a wide range of research on polymer based nanocomposites Provides updates on the most relevant polymer based nanocomposites and their prodigious potential in the fields of energy and the environment Demonstrates systematic approaches and investigations from the design, synthesis, characterization and applications of polymer based nanocomposites Presents a useful reference and technical guide for university academics and postgraduate students (Masters and Ph.D.)

Polymer Nanocomposites

The objective of my research is to develop energy storage device and electrocaloric cooling device based on dielectric materials. The first part of research work is to develop energy storage capacitor with high energy density by nanocomposite approach based on dipolar polymers. The second part of my research work is to develop electrocaloric effect (ECE) based cooling device.Dielectric constant, dielectric breakdown strength, dielectric loss (at high voltage application, conduction loss is also critical), and operating temperature are critical parameters in dielectric materials and their applications. This thesis investigates innovative approaches to enhance these properties of polymer-based dielectrics.Dielectric polymers are widely used in modern electronics due to the low loss and high breakdown strength. The state-of-art material is biaxially oriented polypropylene (BOPP) which has high breakdown strength (>700 MV/m) and low dielectric loss (0.02%). However, it is limited by its low energy density (2 J/cm3) due to the low dielectric constant (k~2.2) and low working temperature (80 C). In order to raise the dielectric constant K of polymer-based dielectrics and hence improve the energy density, nanocomposites in which high volume loading (15 vol%) of high dielectric constant nanofillers (K 1000) is added to a polymer matrix have been widely studied. However, the large dielectric contrast between the nanofillers and polymer matrix and high volume loading of nanofillers result in intensification of local electric fields in the polymer matrix, leading to a large reduction of the dielectric breakdown strength.Recently, Dr. Y Thakur at our group discovered that in dipolar polymer polyetherimide (PEI) (k~3.2), very low volume loading (0.5 vol%) of nanofillers can lead to more than 50% increase in the dielectric constant K and remain high breakdown strength. This thesis investigates whether such an approach can be applied to other dipolar polymers with higher dielectric constant, such as polyimide (PI) (k~3.5) and poly (ether methyl ether urea) (PEMEU) (k~4). The results reveal that the nanocomposites based on these amorphous polymers also have large enhancement of dielectric constant. However, the breakdown strength in these nanocomposites cannot be further improved. Moreover, the presence of nanofillers in amorphous polymers does not reduce the conduction loss at high fields, and hence do not enhance the breakdown strength and do not generate a large improvement in the high temperature performance. I investigated semi-crystal polymer poly (arylene ether urea) (PEEU) and discovered that PEEU nanocomposite with very low volume loading (~ 0.2 vol%) of alumina nanoparticles can significantly enhance the energy density, charge/discharge efficiency and breakdown strength at high temperature. Specifically, we show that PEEU nanocomposite with 0.2 vol% of 20 nm size alumina nanofillers increases both the dielectric constant K and breakdown field E over a broad temperature range to 150 oC. The dielectric constant K is raised from K = 4.7 of the base PEEU to 7.4. At 150 oC, the nanocomposite films exhibit a

breakdown strength of 600 MV/m, increased from 400 MV/m of the base PEEU films. Moreover, nanofiller at such a low loading also significantly reduces the high field conduction loss and, as a result, the PEEU films deliver a discharged Ue of 5 J/cm3 with a high C/D efficiency (> 90%) at 150 oC.I further investigated how the surface modification affect the dielectric constant of nanocomposite. The results show that the dielectric constant enhancement of the nanocomposite with modified surface is reduced. It demonstrates the enhancement of dielectric constant is related to the elastic coupling between polymer matrix and nanoparticles.For nanocomposite approach, the nanofiller dimension is another critical variable. (i) I studied nanocomposite with 1-D nanofiller and found the enhancement is reduced compared with nanocomposites with 0-D nanoparticles. (ii) Poly-p-phenylene benzobisoxazole (PBO) (k~4.5) nanocomposite with 2D nanosheet is also studied (in collaboration with Dr. Cheng Huang of Suzhou University). The results reveal a very large dielectric enhancement. K ~8.7 (loss ~ 1%) was measured for nanocomposites with 1.8 vol% TiO2 nanosheet loading, which is about 2X of the neat PBO. Among all the known polymers, such a high dielectric constant can only be obtained in ferroelectric polymers (such as Polyvinylidene fluoride (PVDF) based polymers). In contrast to PVDF based polymers, the dielectric response of PBO nanocomposites remain linear under high field (200 MV/m). All the above results demonstrates that nanofillers beyond nanoparticles can generate additional variable to enhance the dielectric performance and the dielectric enhancement is determined by the combination of the polymer matrix (structure) and nanofiller (size and dimension).This thesis also investigated another important application of dielectric material, e.g., the electrocaloric effect (ECE) based cooling. The proposed device is based on a counter-rotating disks structure to achieve internal thermal regeneration, thus eliminates the external regenerators and enhances the efficiency. To demonstrate the concept, a commercial multilayer ceramic capacitor (MLCC) was chosen for the EC elements, which generated an EC temperature change of 0.9 K under 200 V. For the EC cooler with two EC rings, which is the minimum required to form a counter-rotating disks device, and at 5 rpm, the device exhibits a temperature lift between the cold and hot ends which is 3X of the EC temperature change of single EC element, demonstrating the concept.

Nanocomposite Science and Technology

Electrical Conductivity in Polymer-Based Composites: Experiments, Modelling and Applications offers detailed information on all aspects of conductive composites. These composites offer many benefits in comparison to traditional conductive materials, and have a broad range of applications, including electronic packaging, capacitors, thermistors, fuel cell devices, dielectrics, piezoelectric functions and ferroelectric memories. Sections cover the theory of electrical conductivity and the different categories of conductive composites, describing percolation threshold, tunneling effect and other phenomena in the field. Subsequent chapters present thorough coverage of the key phases in the development and use of conductive composites, including manufacturing methods, external parameters, applications, modelling and testing methods. This is an essential source of information for materials scientists and engineers working in the fields of polymer technology, processing and engineering, enabling them to improve manufacture and testing methods, and to benefit fully from applications. The book also provides industrial

and academic researchers with a comprehensive and up-to-date understanding of conductive composites and related issues. Explains the methods used in the manufacture and testing of conductive composites, and in the modeling of electrical conductivity Contains specialized information on the full range of applications for conductive composites, including conductive adhesives or pastes Brings scientists, engineers and researchers up-to-date with the latest advances in the field

Interface / Interphase in Polymer Nanocomposites

This book is the translated version of Advanced Nanodielectrics: Fundamentals and Applications, which was published by the Investigating R&D Committee on Advanced Polymer Nanocomposite Dielectrics of the Institute of Electrical Engineers of Japan (IEEJ). The Japanese version is a winner of the IEEJ Outstanding Technical Report Award (2016). Nanocomposites are generally composed of host and guest materials. This book deals with the combination of a polymer as a host with an inorganic filler as a guest. It provides a detailed coverage on the processing and electrical properties of nanocomposites. It gives special consideration to the surface modification of particles, theoretical aspects of the interface, and computer simulation to help the reader develop an understanding of the characteristics of nanocomposites. Moreover, it discusses potential applications of nanocomposites in electric power and electronics sectors. The book is a definitive and practical handbook for beginners as well as experts.

Characterization Techniques for Polymer Nanocomposites

Polymer-Based Multifunctional Nanocomposites and Their Applications provides an up-to-date review of the latest advances and developments in the field of polymer nanocomposites. It will serve as a one-stop reference resource on important research accomplishments in the area of multifunctional nanocomposites, with a particular emphasis placed on the use of nanofillers and different functionality combinations. Edited and written by an expert team of researchers in the field, the book provides a practical analysis of functional polymers, nanoscience, and nanotechnology in important and developing areas, such as transportation engineering, mechanical systems, aerospace manufacturing, construction materials, and more. The book covers both theory and experimental results regarding the relationships between the effective properties of polymer composites and those of polymer matrices and reinforcements. Presents a thorough and up-to-date review of the latest advances and developments in the field of multifunctional polymer nanocomposites Integrates coverage of fundamentals, research and development, and the range of applications for multifunctional polymers and their composites, such as in the automotive, aerospace, biomedical and electrical industries Supports further technological developments by discussing both theory and real world experimental data from academia and industry

AI in Manufacturing and Green Technology

This book provides a comprehensive overview of engineering nanostructures mediated by functional polymers in combination with optimal synthesis and

processing techniques. The focus is on polymer-engineered nanostructures for advanced energy applications. It discusses a variety of polymers that function as precursors, templates, nano-reactors, surfactants, stabilizers, modifiers, dopants, and spacers for directing self-assembly, assisting organization, and templating growth of numerous diverse nanostructures. It also presents a wide range of polymer processing techniques that enable the efficient design and optimal fabrication of nanostructured polymers, inorganics, and organic–inorganic nanocomposites using in-situ hybridization and/or ex-situ recombination methodologies. Combining state-of-the-art knowledge from polymer-guided fabrication of advanced nanostructures and their unique properties, it especially highlights the new, cutting-edge breakthroughs, future horizons, and insights into such nanostructured materials in applications such as photovoltaics, fuel cells, thermoelectrics, piezoelectrics, ferroelectrics, batteries, supercapacitors, photocatalysis, and hydrogen generation and storage. It offers an instructive and approachable guide to polymer-engineered nanostructures for further development of advanced energy materials to meet ever-increasing global energy demands. Interdisciplinary and broad perspectives from internationally respected contributors ensure this book serves as a valuable reference source for scientists, students, and engineers working in polymer science, renewable energy materials, materials engineering, chemistry, physics, surface/interface science, and nanotechnology. It is also suitable as a textbook for universities, institutes, and industrial institutions.

Sustainable Polymer Composites and Nanocomposites

Significant research has been done in polymeric nanocomposites and progress has been made in understanding nanofiller-polymer interface and interphase and their relation to nanocomposite properties. However, the information is scattered in many different publication media. This is the first book that consolidates the current knowledge on understanding, characterization and tailoring interfacial interactions between nanofillers and polymers by bringing together leading researchers and experts in this field to present their cutting edge research. Eleven chapters authored by senior subject specialists cover topics including: Thermodynamic mechanisms governing nanofiller dispersion, engineering of interphase with nanofillers Role of interphase in governing the mechanical, electrical, thermal and other functional properties of nanocomposites, characterization and modelling of the interphase Effects of crystallization on the interface, chemical and physical techniques for surface modification of nanocellulose reinforcements Electro-micromechanical and nanoindentation techniques for interface evaluation, molecular dynamics (MD) simulations to quantify filler-matrix adhesion and nanocomposite mechanical properties.

Polymer Nanocomposites

This book presents emerging economical and environmentally friendly polymer composites that are free of the side effects observed in traditional composites. It focuses on eco-friendly composite materials using granulated cork, a by-product of the cork industry; cellulose pulp from the recycling of paper residues; hemp fibers; and a range of other environmentally friendly materials procured from various sources. The book presents the manufacturing methods, properties and

characterization techniques of these eco-friendly composites. The respective chapters address classical and recent aspects of eco-friendly polymer composites and their chemistry, along with practical applications in the biomedical, pharmaceutical, automotive and other sectors. Topics addressed include the fundamentals, processing, properties, practicality, drawbacks and advantages of eco-friendly polymer composites. Featuring contributions by experts in the field with a variety of backgrounds and specialties, the book will appeal to researchers and students in the fields of materials science and environmental science. Moreover, it fills the gap between research work in the laboratory and practical applications in related industries.

Polymer/layered Silicate Nanocomposites

This book covers graphene reinforced polymers, which are useful in electronic applications, including electrically conductive thermoplastics composites, thermosets and elastomers. It systematically introduces the reader to fundamental aspects and leads over to actual applications, such as sensor fabrication, electromagnetic interference shielding, optoelectronics, superconductivity, or memory chips. The book also describes dielectric and thermal behaviour of graphene polymer composites - properties which are essential to consider for the fabrication and production of these new electronic materials. The contributions in this book critically discuss the actual questions in the development and applications of graphene polymer composites. It will thus appeal to chemists, physicists, materials scientists as well as nano technologists, who are interested in the properties of graphene polymer composites.

Advances in Polymer Nanocomposites

Containing selected presentations from both academic institutions and industry held at the 17th European Symposium on Polymer Spectroscopy (ESOPS17), this volume covers the latest developments in the spectroscopic characterization of polymeric materials. As such, the papers cover such methods as infrared and Raman spectroscopy and imaging, NMR and ESR spectroscopy, dielectric spectroscopy, also in combination with light and electron microscopy and near-field imaging.

Polymer Dielectrics

Both an introductory course to broadband dielectric spectroscopy and a monograph describing recent dielectric contributions to current topics, this book is the first to cover the topic and has been hotly awaited by the scientific community.

Dielectric Polymer Materials for High-Density Energy Storage

The review sets out to highlight the major developments in this field over the last decade. The different techniques used to prepare PLS nanocomposites are covered. The physicochemical characterisation of PLS nanocomposites and the improved materials properties that those materials can display are discussed. An additional indexed section containing several hundred abstracts from the Rapra

Polymer Library database provides useful references for further reading.

Polymer-Engineered Nanostructures for Advanced Energy Applications

Abstract : Introducing a high dielectric constant (high- k) nanofiller into a dielectric polymer is the most common way to achieve flexible nanocomposites for electrostatic energy storage devices. Abstract : Introducing a high dielectric constant (high- k) nanofiller into a dielectric polymer is the most common way to achieve flexible nanocomposites for electrostatic energy storage devices. However, the significant decrease of breakdown strength and large increase of dielectric loss has long been known as the bottleneck restricting the enhancement of practical energy storage capability of the nanocomposites. In this study, by introducing ultra-small platinum (

Polymer Nanocomposites in Biomedical Engineering

The aim of the present edited book is to furnish scientific information about manufacturing, properties, and application of clay and carbon based polymer nanocomposites. It can be used as handbook for undergraduate and post graduate courses (for example material science and engineering, polymer science and engineering, rubber technology, manufacturing engineering, etc.) as well as as reference book for research fellows and professionals. Polymer nanocomposites have received outstanding importance in the present decade because of their broad range of high-performance applications in various areas of engineering and technology due to their special material properties. A great interest is dedicated to nanofiller based polymeric materials, which exhibit excellent enhancement in macroscopic material properties (mechanical, thermal, dynamic mechanical, electrical and many more) at very low filler contents and can therefore be used for the development of next-generation composite materials.

Properties and Applications of Polymer Nanocomposites

Dielectric Polymer Materials for High-Density Energy Storage begins by introducing the fundamentals and basic theories on the dielectric behavior of material. It then discusses key issues on the design and preparation of dielectric polymer materials with strong energy storage properties, including their characterization, properties and manipulation. The latest methods, techniques and applications are explained in detail regarding this rapidly developing area. The book will support the work of academic researchers and graduate students, as well as engineers and materials scientists working in industrial research and development. In addition, it will be highly valuable to those directly involved in the fabrication of capacitors in industry, and to researchers across the areas of materials science, polymer science, materials chemistry, and nanomaterials. Focuses on how to design and prepare dielectric polymer materials with strong energy storage properties Includes new techniques for adjusting the properties of dielectric polymer materials Presents a thorough review of the state-of-the-art in the field of dielectric polymer materials, providing valuable insights into potential avenues of development