Science And Technology Of Polymer Nanofibers

Polymer NanofibersApplications of Polymer NanofibersAn Introduction To Electrospinning And NanofibersElectrospun Polymer NanofibersScience and Technology of Polymer NanofibersApplications of Polymer NanofibersPolymeric NanofibersGeneration of Polymer Nanofibers Through ElectrospinningStructure, Processing, and Properties of Polymer Nanofibers for Emerging TechnologiesElectrospun Conducting Polymer Nanofibers for Biomedical ApplicationsBiomedical Applications of Polymeric NanofibersElectrospun Polymer NanofibersSelf-Assembled Nanomaterials IFabrication of Polymer Nanofibers Via Modified Wet SpinningFunctional Conducting Polymer Nanomaterials and Bioactive Polymer Nanofibers for Neural Prosthetic - Nervous System InterfacesElectrospun Polymer Nanofibers for Food and Health ApplicationsElectrospinning Scaffold Fabrication of Polymer Nanofibers and Sensors for Tissue Engineering ApplicationsElectrospun Polymer Nanofibers for Food and Health ApplicationsStructure, Processing, and Properties of Polymer Nanofibers for Emerging TechnologiesHandbook of Electrospun Polymer Nanofibers Dario Pisignano Anthony L. Andrady Seeram Ramakrishna Arkadii Arinstein Anthony L. Andrady Anthony L. Andrady Darrell H. Reneker United States. National Technical Information Service Norizah Abdul Rahman Rangasamy Jayakumar Arkadii Arinstein Toshimi Shimizu Murali Gorantla Mohammad Reza Abidian Marija Gizdavic-Nikolaidis Dennis LeRoy Edmondson Marija Gizdavic-Nikolaidis Zhai

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research into polymer nanofibers has increased significantly over the last decade prompting the need for a comprehensive monograph examining the subject as knowledge of their properties and potential applications has increased postgraduate students and researchers new to the field will benefit from the from materials to applications approach to the book which examines the physio chemical properties in detail demonstrating how they can be exploited for a diverse range of applications including the production of light and wound dressings techniques for the fabrication notably electrospinning are discussed at length this book provides a unique and accessible source of information summarising the last decade of the field and presenting an entry point for those entering the field and an inspiration to established workers the author is currently the national coordinator for several research projects examining the applications of polymer nanofibers alongside active international collaborations

applications of polymer nanofibers explore a comprehensive review of the practical experimental and technological details of polymer nanofibers with a leading new resource applications of polymer nanofibers delivers a complete introduction to the basic science of polymer nanofibers as well as a review of their diverse applications the book assesses their potential for commercialization and presents contributions from leading experts emphasizing their practical and technological details new and up to date research findings are presented throughout the book in areas including filters fabric energy fuel cells batteries sensors biomedicine drug delivery tissue engineering and wound dressings the book also presents a fulsome analysis of the technology of electrospinning the most convenient and scalable technique for nanofiber production it also provides readers with practical information on relevant surface modification techniques applications of polymer nanofibers effectively balances theoretical background with practical applications of the technology including insights into polymer nanofiber materials that will be useful for advanced students and researchers students researchers and industry professionals will also enjoy the inclusion of a thorough introduction to electrospinning parameters and resulting nanofiber characteristics including theoretical and practical considerations an exploration of textile applications of nanofibers like protective clothing filter fabrics wearable devices functional fabrics and biomedical textiles a review of nanofiber mats as high efficiency filters including filtration developments filters made with nanofibers and the future outlook for nanofiber filters a treatment of nanofiber based chemical sensors including sensor materials approaches to nanofiber sensor design and gravimetric nanofiber sensors perfect for researchers and graduate students studying polymer science and engineering chemical engineering materials science and nanotechnology applications of polymer nanofibers will also earn a place in the libraries of industrial researchers concerned with electrospinning air filtration fabrics drug delivery catalysis and biomedicine

the research and development of nanofibers has gained much prominence in recent years due to the heightened awareness of its potential applications in the medical engineering and

defense fields among the most successful methods for producing nanofibers is the electrospinning process in this timely book the areas of electrospinning and nanofibers are covered for the first time in a single volume the book can be broadly divided into two parts the first comprises descriptions of the electrospinning process and modeling to obtain nanofibers while the second describes the characteristics and applications of nanofibers the material is aimed at both newcomers and experienced researchers in the area

discussing the electrospinning process the book covers in great depth the current research interest in nanoscience and nanotechnology especially electrospinning of polymer nanofibers the main distinction of the proposed book from others devoted to the electrospinning process is in the consideration of the problem in question from the physical point of view focusing on physical aspects the book contains physical basics regarding the unique features of electrospun polymer nanofibers and the electrospinning resulting in fabrication of these nanofibers

discover new and emerging applications of polymer nanofibers alongside the basic underlying science and technology with discussions exploring such practical applications as filters fabrics sensors catalysts scaffolding drug delivery and wound dressings the book provides polymer scientists and engineers with a comprehensive practical how to reference moreover the author offers an expert assessment of polymer nanofibers near term potential for commercialization among the highlights of coverage is the book s presentation of the science and technology of electrospinning including practical information on how to electrospin different polymer systems

applications of polymer nanofibers explore a comprehensive review of the practical experimental and technological details of polymer nanofibers with a leading new resource applications of polymer nanofibers delivers a complete introduction to the basic science of polymer nanofibers as well as a review of their diverse applications the book assesses their potential for commercialization and presents contributions from leading experts emphasizing their practical and technological details new and up to date research findings are presented throughout the book in areas including filters fabric energy fuel cells batteries sensors biomedicine drug delivery tissue engineering and wound dressings the book also presents a fulsome analysis of the technology of electrospinning the most convenient and scalable technique for nanofiber production it also provides readers with practical information on relevant surface modification techniques applications of polymer nanofibers effectively balances theoretical background with practical applications of the technology including insights into polymer nanofiber materials that will be useful for advanced students and researchers students researchers and industry professionals will also enjoy the inclusion of a thorough introduction to electrospinning parameters and resulting nanofiber characteristics including theoretical and practical considerations an exploration of textile applications of nanofibers like protective clothing filter fabrics wearable devices functional fabrics and biomedical textiles a review of nanofiber mats as high efficiency filters including filtration developments filters made with nanofibers and the future outlook for nanofiber filters a

treatment of nanofiber based chemical sensors including sensor materials approaches to nanofiber sensor design and gravimetric nanofiber sensors perfect for researchers and graduate students studying polymer science and engineering chemical engineering materials science and nanotechnology applications of polymer nanofibers will also earn a place in the libraries of industrial researchers concerned with electrospinning air filtration fabrics drug delivery catalysis and biomedicine

polymeric nanofibers will showcase recent developments in the production characterization and emerging use of nanofibers made from different polymers for a variety of purposes although it has been difficult to produce polymer fibers in the laboratory electrospinning now makes it easier electrospinning an electrohydrodynamical process for making thin polymer fibers with diameters in the range from around one nanometer to several thousands of nanometers is simple and cost effective interest in other specialized routes to polymer nanofibers including chemical synthesis conventional textile fiber spinning gas blowing and other methods has been stimulated by the recent progress in electrospinning scientists and engineers in fields such as filtration biomaterials biomedical devices chemical analysis catalysis aerospace fiber reinforced composites energy conversion protective clothing agriculture and others can produce experimental quantities of nanofibers in their own laboratories from a wide variety of polymers of interest to them the number of papers and patents in electrospinning has grown at a rapid rate during the past decade more than doubling each year since 1999

conducting polymer cp nanofibers have recently received great attention due to their high surface area per volume and extensive porosity combined with unique properties such as high electrical conductivity or fluorescence these materials are being considered for a range of novel applications including biomedical applications among the techniques used for the preparation of polymer nanofibers electrospinning is a simple fast and relatively cheap technique the focus of this thesis is to develop conducting polymer micro nanofibers with a well defined morphology using electrospinning and to investigate their potential in two areas of biomedical applications tissue engineering and dna sensing two classes of conducting polymers polyaniline pani and poly p phenylene vinylene ppv were used in this study to produce cp nanofibers soluble copolymers of aniline ani and m aminobenzoic acid m aba were synthesized to improve the solubility of pani the properties of these polymers were characterized and studied using a range of techniques the solubility of the copolymers increased with an increase in the m aba content conversely the conductivity of the copolymers was lowered the average molecular weight of the copolymers as determined by gel permeation chromatography was found to decrease from 13 800 to 1 640 g mol 1 with an increase of m aba content in the copolymer from 0 2 to 0 8 by contrast ft ms results revealed that homopolymerization of m aba formed oligomers rather than polymeric chains based upon a consideration of the solubility and electrical conductivity of the copolymers an ani to m aba copolymer ratio of 60 40 was chosen for electrospinning with the biocompatible and biodegradable polymer poly lactic acid pla these polymers were electrospun with mean fiber diameters of 100 400 nm ftir raman spectroscopy and conductivity measurements confirmed the incorporation of conducting co

polymers within the pla based nanofibers the elastic modulus of a single nanofiber was examined using a nanoindenter instrument for the first time the nanoindentation results obtained on the individual nanofibers revealed that the elastic moduli of the nanofibers were much higher at the surface than in the inner fiber core these fibers thereby provide cells with stiff sub micron sized fibers as anchoring points on a substrate of high porosity the conductive nature of these composite nanofibers offers exciting opportunities for electrical stimulation of cells human adipose derived stem cells hasc were used in this work to evaluate the biocompatibility of the nanofibers an important characteristic of a scaffold in tissue engineering the cell culture results showed that the composite nanofibers supported hasc adhesion and proliferation to a similar degree as control surfaces namely electrospun pla nanofibers and tissue culture treated glass substrates tcs depending on the fiber composition the cells initially displayed some variation in the extent of focal adhesions fas after three days of culturing but after one week all of the samples showed similar cell densities and morphologies a luminescent conducting polymer a ppv derivative poly 6 6 2 methyl 5 e 4 e prop 1 en 1 yl styryl 1 4 phenylene bis oxy dihexanoic acid pdmp was electrospun into nanofibers using the same method as described above pla was again chosen for electrospinning with pdmp in various pla pdmp compositions the morphology of the novel pla pdmp composite nanofibers was studied extensively using a scanning electron microscope sem the composite nanofibers were also used to construct a simple oligonucleotide odn sensor where capture probe odns capodn were covalently grafted onto the residual carboxylic acid functionalities of the composite nanofibers the dna sensing results revealed that significant non specific interactions occur which can be prevented to some extent by changing the dye attached to the signal probe the results also indicate the potential of such nanofibers to be used as biodegradable biosensor

multiscale fibrous scaffolds in regenerative medicine by sowmya srinivasan r jayakumar k p chennazhi erica j levorson antonios g mikos and shantikumar v nair stem cells and nanostructures for advanced tissue regeneration by molamma p prabhakaran j venugopal laleh ghasemi mobarakeh dan kai guorui jin and seeram ramakrishna creating electrospun nanofiber based biomimetic scaffolds for bone regeneration by eleni katsanevakis xuejun wen and ning zhang synthetic biopolymer nanofibrous composites as dynamic tissue engineering scaffolds by j a kluge and r l mauck electrospun fibers as substrates for peripheral nerve regeneration by jörg mey gary brook dorothée hodde and andreas kriebel highly aligned polymer nanofiber structures fabrication and applications in tissue engineering by vince beachley eleni katsanevakis ning zhang xuejun wen electrospinning of biocompatible polymers and their potentials in biomedical applications by pitt supaphol orawan suwantong pakakrong sangsanoh sowmya srinivasan rangasamy jayakumar and shantikumar v nair electrospun nanofibrous scaffolds current status and prospects in drug delivery by m prabaharan r jayakumar and s v nair biomedical applications of polymer silver composite nanofibers by r jayakumar m prabaharan k t shalumon k p chennazhi and s v nair

this text was ranked by isi as having the highest impact factor of all publications within polymer science it is a collection of concise reports on the physics and chemistry of polymers

the electrospinning method has the unique ability to produce structured polymeric fibers on the micro or nano scale and to generate novel materials for food and healthcare purposes the potential of electrospun nanofibers for human healthcare applications is promising for example in tissue organ repair and regeneration in medical diagnostics and instrumentation and as vectors to deliver drugs and therapeutics as biocompatible and biodegradable medical implant devices as protective fabrics against environmental and infectious agents in hospitals and general surroundings furthermore considerable effort has been directed toward developing scaffolds using biodegradable and biocompatible synthetic natural polymers or renewable materials that enhance in vitro cell growth while killing pathogenic bacteria cells this special issue electrospun polymer nanofibers for food and health applications will cover the latest research of electrospun nanofibres in this field including shape memory electrospun fibre meshes with programmable cell orientation water absorbing nanofiber meshes for efficient removal of excess water from kidney failure patients and hydrogel nanofibers which can be used as a drug carrier for methylene blue

well ordered one dimensional nanostructures nanofibers are enabling important new applications in textile energy structural environmental and bioengineering applications such as sensors transducers and energy harvesters due to their unique anisotropic properties through electrospinning polymeric ceramic or metallic solutions can be ejected from an electrically charged syringe needle spinneret at an appropriate flow rate collection distance and voltage to form nanofiber filaments a substantial electrical field gradient of 6 000 to 25 000 volts is required depending on solution type in the space between the charged syringe needle spinneret and an electrically grounded collection electrode as solution flows from the syringe needle coulomb forces created by electrical charge on fibers can extend the stream into a fine continuous group of filaments the short transition from spinneret blunt needle tip to the stream occurs through formation of a taylor cone droplet at an angle of around 30 degrees to the needle tip axis which is a common characteristic for charged fluids in motion within electric field gradients the electric field gradient accelerates the filament stream onto a collecting target of opposite polarity between eight and thirty centimeters away for best circumstances the polymeric solution should be dry upon reaching the grounded collecting electrode to yield a dry fibrous mat resultant fiber diameter or shape porosity morphology and other characteristics can be controlled through modifying electrospinning solution material composition voltage solution flow rate natural or forced electric field strength and distance between spinneret needle and fiber collector geometry the collector component is very significant to the electrospinning process as the fiber collector geometry can be altered to control fiber deposition orientation electrospinning fabrication equipment designed for manufacturing nanofibers especially for highly aligned fibers can be used to develop effective scaffolds for cell proliferation and chemical attachment many electrospinner variations have been tried in the effort to create a bio cellular scaffold environment on which cells can proliferate the ability to promote substantial cell growth on an artificial scaffold brings research closer to fabrication of difficult organs such as heart neural conduits intestinal tissue and skeletal structure to name but a few current laboratory and clinical trials focused on bladder and kidney are searching for the ideal

technique for creating a fully functioning replacement organ by identifying the most reliable polymer fiber cell compatibility scaffold that will both support cell proliferation and be biodegradable a key aspect is developing a consistent method of aligning fibers through electrospinning however the challenges in large scale production of highly aligned and uniform nanofibers limit the scope of their applications and commercialization this dissertation presents a powerful yet economical approach that integrates the concepts of stationary parallel electrode gap method with centrifugal polymer dispersion to produce nanofibers with a high degree of alignment and uniformity at large scale this approach was first demonstrated with polyvinylidene fluoride to illustrate how the experimental parameters regulate fiber production and piezoelectric response leading to the production of aligned nanofibers up to four inches in length further work with chitosan and polyethylene oxide a natural and a synthetic polymer demonstrated the versatility of the system the now patented centrifugal electrospinning technology presented here has already opened new avenues of invention through mass production of aligned nanofibers allowing development of novel sensors one novel device under development is a spiral coiled biosensor biotelemetry has become an important part of medical research for advancing patient care by remotely monitoring continuing biological processes and physiological functions current biotelemetry systems are complex and require multiple electronic components to function for example battery sensor element and transmitter circuit another significant concern of current biotelemetry devices is direct wire coupling of the in vivo portion to external supporting equipment without the need for a power supply the spirally coiled sensors in the nanofiber bundle generate and transmit an electrical signal wirelessly in response to deflections the sensor is encapsulated within a thin biocompatible polymer shell of poydimethylsiloxane pdms providing device integrity and moisture isolation the results suggest that such a sensor can potentially function as both mechanical and biotelemetry sensors for various in vitro and in vivo biomedical applications the following chapters discuss how combining technologies of selected organic polymer materials and fiber electro spinning apparatus with cell immobilization procedures determines electrospun fiber mat effectiveness several examples demonstrate how a solution of electrospun biocompatible nanofibers composed of polymer s can be used to control time rate of degradation and produce a nanofiber scaffold structure supporting attachment and proliferation of cells of interest for in vitro application they show in detail how cells combined with artificial extra cellular matrix ecm of desirable biocompatible and biodegradable characteristics are important to tissue engineering research several polymers both natural and synthetic including alginate chitosan polyethylene oxide peo polycaprolactone pcl and piezoelectric polyvinylidene fluoride pvdf compositions for electrospinning are presented piezoelectric nanofibers that could offer many useful applications were electrospun solutions having different composition ratios producing random and semi aligned nanofibers through standard electrospinning collector electrode techniques are discussed as is a newly developed aligned fiber electrospinner that uses centrifugal force with pneumatic assistance to produce a highly viscous solution rendering the fibers electrospinable a novel biotelemetry sensor owes its embryonic beginnings to highly aligned nanofibers created through centrifugal electrospinning through these techniques simple

highly aligned piezoelectric polyvinylidene fluoride and tetrafluoralethane nanofibers can be fabricated to function as a standalone power source sensor and transmitter

the electrospinning method has the unique ability to produce structured polymeric fibers on the micro or nano scale and to generate novel materials for food and healthcare purposes the potential of electrospun nanofibers for human healthcare applications is promising for example in tissue organ repair and regeneration in medical diagnostics and instrumentation and as vectors to deliver drugs and therapeutics as biocompatible and biodegradable medical implant devices as protective fabrics against environmental and infectious agents in hospitals and general surroundings furthermore considerable effort has been directed toward developing scaffolds using biodegradable and biocompatible synthetic natural polymers or renewable materials that enhance in vitro cell growth while killing pathogenic bacteria cells this special issue electrospun polymer nanofibers for food and health applications will cover the latest research of electrospun nanofibres in this field including shape memory electrospun fibre meshes with programmable cell orientation water absorbing nano ber meshes for e cient removal of excess water from kidney failure patients and hydrogel nano bers which can be used as a drug carrier for methylene blue

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