

# Reinforcing Fillers In The Rubber Industry Assessment As

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Innovative Design, Analysis and Development Practices in Aerospace and Automotive Engineering (I-DAD 2018) - U. Chandrasekhar  
2018-12-14

The book includes the best articles presented by researchers, academicians and industrial experts

at the International Conference on “Innovative Design and Development Practices in Aerospace and Automotive Engineering (I-DAD 2018)”. The book discusses new concept in designs, and analysis and manufacturing technologies for improved performance through specific and/or

multi-functional design aspects to optimise the system size, weight-to-strength ratio, fuel efficiency and operational capability. Other aspects of the conference address the ways and means of numerical analysis, simulation and additive manufacturing to accelerate the product development cycles. Describing innovative methods, the book provides valuable reference material for educational and research organizations, as well as industry, wanting to undertake challenging projects of design engineering and product development.

**Additives for Plastics** - Jan Stipek 2012-12-06

This book deals with the most important substances used as additives in the plastics industry to improve the properties of polymer-based materials. Each chapter deals with a particular type of additive based on the type's definition, structure, and classification according to main effects on polymeric materials. The mechanism of the additive efficiency and its effects on basic properties of specific polymers

are discussed and a survey of its important qualities and practical applications is given. Each chapter is introduced by a theoretical analysis of the practical and technological importance of the additive. The book is mainly intended for students in technical colleges, polytechnics and universities who are studying plastics technology and macromolecular chemistry as part of their general curriculum and for technologists in industry engaged in development, sales, technical service and production functions, and applications of plastics. An elementary knowledge of chemistry, physical chemistry and polymer science at the technical college level is assumed. Prague and Montreal, December 1982 J. Stepek, H. Daoust  
Table of Contents Introduction .

**InCIEC 2014** - Rohana Hassan 2015-05-11

The special focus of this proceedings is to cover the areas of infrastructure engineering and sustainability management. The state-of-the art information in infrastructure and sustainable

issues in engineering covers earthquake, bioremediation, synergistic management, timber engineering, flood management and intelligent transport systems. It provides precise information with regards to innovative research development in construction materials and structures in addition to a compilation of interdisciplinary finding combining nano-materials and engineering.

**Physical Properties of Polymers Handbook** - James E. Mark 2007-03-21

This book offers concise information on the properties of polymeric materials, particularly those most relevant to physical chemistry and chemical physics. Extensive updates and revisions to each chapter include eleven new chapters on novel polymeric structures, reinforcing phases in polymers, and experiments on single polymer chains. The study of complex materials is highly interdisciplinary, and new findings are scattered among a large selection of scientific and engineering journals. This book

brings together data from experts in the different disciplines contributing to the rapidly growing area of polymers and complex materials.

*Hazards in the European Rubber Industry* 1999

Constitutive Models for Rubber IV - Per-Erik Austrell 2017-12-04

The unique properties of elastomeric materials offer numerous advantages in many engineering applications. Elastomeric units are used as couplings or mountings between rigid components, for example in shock absorbers, vibration insulators, flexible joints, seals and suspensions, etc. However, the complicated nature of the behaviour of such material makes it difficult to accurately predict the performance of these units using finite element modelling, for example. It is imperative that constitutive models accurately capture relevant aspects of mechanical behaviour. The latest developments concerning constitutive modelling of rubber is

collected in these Proceedings. Topics included in this volume are, Hyperelastic models, Strength, fracture & fatigue, Dynamic properties & the Fletcher-Gent effect, Micro-mechanical & statistical approaches, Stress softening, iscoelasticity, Filler reinforcement, and Tyres, fibre & cord reinforced rubber.

**Raw Materials Supply Chain for Rubber Products** - John S. Dick 2014-06-30

The rubber industry is a vital part of the world economy. In this age of constantly changing economics and raw material "shortages of the week," this book should help the reader understand the overall technical and economic problems that are emerging which are beginning to affect the overall availability of many raw materials, chemical intermediates and final rubber products on the world scene. This book is truly unique in that it is the only one that traces all the important organic and inorganic synthesis routes for the manufacture of synthetic rubbers, various fillers, plasticizers, oils, curatives,

antidegradants, adhesion promoters, flame retardants, tackifiers, and blowing agents through their respective intermediates to the base raw materials from earth extractions and agriculture.

*Science and Technology of Rubber* James E. Mark 2011-07-28

The 3rd edition of *The Science and Technology of Rubber* provides a broad survey of elastomers with special emphasis on materials with a rubber-like elasticity. As in the 2nd edition, the emphasis remains on a unified treatment of the material; exploring topics from the chemical aspects such as elastomer synthesis and curing, through recent theoretical developments and characterization of equilibrium and dynamic properties, to the final applications of rubber, including tire engineering and manufacturing. Many advances have been made in polymer and elastomers research over the past ten years since the 2nd edition was published. Updated material stresses the continuous relationship

between the ongoing research in synthesis, physics, structure and mechanics of rubber technology and industrial applications. Special attention is paid to recent advances in rubber-like elasticity theory and new processing techniques for elastomers. This new edition is comprised of 20% new material, including a new chapter on environmental issues and tire recycling. · Explores new applications of rubber within the tire industry, from new filler materials to “green tires (a tire that has yet to undergo curing and vulcanization). · 30% of the material has been revised from the previous edition with the addition of 20% new material, including a chapter on the environment. · A mixture of theory, experiments, and practical procedures will offer value to students, practitioners, and research & development departments in industry.

**Rubber Based Bionanocomposites** - Visakh P. M. 2017-03-15  
Leading researchers from industry, academy,

government and private research institutions across the globe have contributed to this book, which presents all types of rubber blend composites based on biomaterials as well as nanocomposites. It discusses the fundamental preparation methods of these materials and summarizes many of the latest technical research advances, offering an essential guide for academics, researchers, scientists, engineers and students alike.

New Developments in Polymer Analysis, Stabilization and Degradation - Gennadii Efremovich Zaikov 2005

New Developments in Polymer Analysis, Stabilisation & Degradation

Rubber Technology - John S. Dick 2009

*Engineering and Technical Development for a Sustainable Environment* Dzaraini Kamarun 2017-11-23

This volume covers a diverse array of alternative technologies and their development with

particular attention to the utilization of bioresources for the achievement of a sustainable environment. The book presents a selection of alternative technologies being used in developing and developed countries that can be indigenous to the region, cost-effective, and often driven by dominant societal interest and geographical status. Several engineering and technological processes are included to mark their importance in product performance and preservation of the environment. Topics cover: • strategies for the management of rain and ground water for consumption • wastewater treatment using indigenous techniques of phytoremediation • scientific and engineering approaches to the prevention of flood and landslides in the tropics • wind power generation • soil evaluation of contamination due to heavy metals • green and sustainable building approaches • bioethanol production • energy conservation techniques Refreshing and informative, Engineering and Technical

Development for a Sustainable Environment revisits conventional approaches of managing natural agents (such as wind, rain and groundwater resources as well as wastewater treatment) in light of current sustainable-oriented techniques using modern scientific concepts and strategies. It presents in-depth evaluations and analyses using systematic up-to-date scientific and engineering tools.

**Encyclopedia of Polymers and Composites -**  
Sanjay Palsule 2021-01-14

The Encyclopedia of Polymers and Composites provides all details of Polymeric Materials Science and Technology including historical developments, present status, and future potential. In 15 volumes, the Encyclopedia of Polymers and Composites covers: polymeric materials, engineering polymer blends, particulate and fibrous polymeric composite materials, that are the key materials for technology in the 21st Century. Fundamentals of structure of these materials are presented.

Properties and effects of various parameters, like time and temperature on them are explained. Testing and Characterization of these materials as per global standard for various applications is presented. Individual polymers, blends, and composites are described, and several representative examples are also provided. The Encyclopedia also provides directions for future developments. It is organized in alphabetical order.

### **Reverse Engineering of Rubber Products -**

Saikat Das Gupta 2013-09-19

Reverse engineering is widely practiced in the rubber industry. Companies routinely analyze competitors' products to gather information about specifications or compositions. In a competitive market, introducing new products with better features and at a faster pace is critical for any manufacturer. Reverse Engineering of Rubber Products: Concepts, Tools, and Techniques explains the principles and science behind rubber formulation

development by reverse engineering methods. The book describes the tools and analytical techniques used to discover which materials and processes were used to produce a particular vulcanized rubber compound from a combination of raw rubber, chemicals, and pigments. A Compendium of Chemical, Analytical, and Physical Test Methods Organized into five chapters, the book first reviews the construction of compounding ingredients and formulations, from elastomers, fillers, and protective agents to vulcanizing chemicals and processing aids. It then discusses chemical and analytical methods, including infrared spectroscopy, thermal analysis, chromatography, and microscopy. It also examines physical test methods for visco-elastic behavior, heat aging, hardness, and other features. A chapter presents important reverse engineering concepts. In addition, the book includes a wide variety of case studies of formula reconstruction, covering large products such as tires and belts as well as smaller

products like seals and hoses. Get Practical Insights on Reverse Engineering from the Book's Case Studies Combining scientific principles and practical advice, this book brings together helpful insights on reverse engineering in the rubber industry. It is an invaluable reference for scientists, engineers, and researchers who want to produce comparative benchmark information, discover formulations used throughout the industry, improve product performance, and shorten the product development cycle.

*Nanotechnology and Tyres Greening Industry and Transport*- OECD 2014-07-18

This report provides insights into the policy issues related to nanotechnology use in the tyre industry: the status of nanotechnology innovation, the economic and social costs and benefits, their safe use, and decision making.

Fillers for Polymer Applications - Roger Rothon 2017-05-10

This handbook provides an introduction to and reference information about the science behind

the production and use of particulate fillers in polymer applications. Fillers play an important role and are used with practically all types of polymers: thermoplastics, thermosets, elastomers. Readers will find an introduction to the topic of particulate fillers for polymer applications and their importance. The first chapters describe the use and characteristics of fillers in different polymer types, such as thermoplastics, thermosets and elastomers. The following chapters compile and summarize comprehensive information about different filler materials which find application nowadays, including mineral fillers (for example feldspars, wollastonites, and many more) and inorganic fillers (barium sulphate, or clays), bio-fillers, recycled and sustainable fillers, and fillers for specific applications (for example flame-retardant fillers, fillers for electrically conductive applications, or thermally conductive additives). Offering key information, compiled by a mixed team of authors from academia and

industry, this handbook will appeal to researchers and professionals working on and with particulate polymer fillers alike.

*Reinforcement of Elastomers* Gerard Kraus  
1965

Graphene-Rubber Nanocomposites - Titash

Mondal 2022-10-24

Since the Nobel Prize for the discovery of graphene was presented in 2010, graphene has been frequently leveraged for different applications. Owing to the strategic importance of elastomer-based products in different segments, graphene and its derivatives are often added to different elastomers to improve their properties. *Graphene-Rubber Nanocomposites: Fundamentals to Applications* provides a comprehensive and innovative account of graphene-rubber composites. Features: Provides up-to-date information and research on graphene-rubber nanocomposites Presents a detailed account of the different niche

applications ranging from sensors, flexible electronics to thermal, and EMI shielding materials Offers a comprehensive know-how on the structure-property relationship of graphene-rubber nanocomposites Covers the characterization of graphene-based elastomeric composition Delivers a comprehensive understanding of the structure of the graphene, including its chemical modification for usage in elastomer composites This book will be a valuable resource for graduate-level students, researchers, and professionals working in the fields of materials science, polymer science, nanoscience and technology, rubber technology, chemical engineering, and composite materials. *Rubber Recycling* Jin Kuk Kim 2018-10-03 Rubber is used in a vast number of products, from tyres on vehicles to disposable surgical gloves. Increasingly both manufacturers and legislators are realising that recycling is essential for environmental sustainability and can improve the cost of manufacture. The

volume of rubber waste produced globally makes it difficult to manage as accumulated waste rubber, especially in the form of tyres, can pose a significant fire risk. Recycling rubber not only prevents this problem but can produce new materials with desirable properties that virgin rubbers lack. This book presents an up-to-date overview of the fundamental and applied aspects of renewability and recyclability of rubber materials, emphasising existing recycling technologies with significant potential for future applications along with a detailed outline of new technology based processing of rubber to reuse and recycle. This book will be of interest to researchers in both academia and industry as well as postgraduate students working in polymer chemistry, materials processing, materials science and engineering.

**Rubber Nanocomposites** - Sabu Thomas

2010-04-09

Rubber Nanocomposites: Preparation, Properties and Applications focuses on the

preparation, characterization and properties of natural and synthetic rubber nanocomposites. The book carefully debates the preparation of unmodified and modified nanofillers, various manufacturing techniques of rubber nanocomposites, structure, morphology and properties of nanocomposites. The text reviews the processing; characterization and properties of 0-, 1D and 2D nanofiller reinforced rubber nanocomposites. It examines the polymer/filler interaction, i.e., the compatibility between matrix and filler using unmodified and modified nanofillers. The book also examines the applications of rubber nanocomposites in various engineering fields, which include tyre engineering. The book also examines the current state of the art, challenges and applications in the field of rubber nanocomposites. The handpicked selection of topics and expert contributions make this survey of rubber nanocomposites an outstanding resource for anyone involved in the field of polymer materials

design. A handy "one stop" reference resource for important research accomplishments in the area of rubber nanocomposites. Covers the various aspects of preparation, characterization, morphology, properties and applications of rubber nanocomposites. Summarizes many of the recent technical research accomplishments in the area of nanocomposites, in a comprehensive manner. It covers an up to date record on the major findings and observations in the field.

### **Recent Advances in Elastomeric**

**Nanocomposites** - Vikas Mittal 2011-01-15

'Recent Advances in Elastomeric Nanocomposites' reviews the recent progresses in the synthesis, processing as well as applications of elastomeric nanocomposites. Elastomers are a very important class of polymer materials and the generation of their nanocomposites by the incorporation of nano-filler has led to significant enhancement of their properties and, hence, expansion of their

application potential. Most of the studies related with these materials are present in the form of research papers. Here, the authors present a comprehensive text covering the whole of the subject. The book is tailored more from the applications point of view, but also provide enough introductory material for research scholars new to this field.

### **Current Topics in Elastomers Research** - Anil

K. Bhowmick 2008-05-07

From weather-proof tires and artificial hearts to the o-rings and valve seals that enable successful space exploration, rubber is an indispensable component of modern civilization. Stiff competition and stringent application requirements foster continuous challenges requiring manufacturers to fund ever-expanding research projects. However, this was Rubber Reinforcement with Particulate Fillers - Meng-Jiao Wang 2021-05-10

In the rubber industry, one of the most widely practiced processes is the reinforcement of

rubber by particulate fillers, especially carbon black and silica. This process is of such importance that more than 99% of rubber products contain fillers, and the research and development of fillers have become the most widely researched area in rubber science and technology. This book covers the most important theoretical and practical aspects of rubber reinforcement, such as filler basic properties and their characterization methods, the effect of fillers in polymers, the processability of compounds, and the properties of filled vulcanizates. Special chapters deal with applications of fillers in tires and industrial rubber goods and the reinforcement of silicone rubbers. Testing methods and their principles, applications, and limitations are reviewed, with emphasis on the surface activity, widely accepted as the “third dimension” of filler characterization, after particle size and structure. This has not been described in depth in other books on rubber reinforcement. The

effects of fillers on rubber and their mechanisms, which are important links between filler properties and the performance of rubber goods, are explained. A guide for selecting the most appropriate reinforcing systems for specific applications is provided, taking into account processabilities and properties of filled compounds and performance of rubber products. With solutions to many practical problems related to rubber research and compounding, this book serves as a valuable companion to engineers and product developers in the rubber industry, material scientists, and teachers and students in material science and rubber courses. Constitutive Models for Rubber VIII - Nere Gil-Negrete 2013-06-03

Due to their unique properties, rubber materials are found in multiple engineering applications such as tires, engine mounts, shock absorbers, flexible joints, seals, etc. Nevertheless, the complex nature of the behavior of such material makes it difficult to accurately model and

predict the performance of these units. The challenge to correctly rep

An Introduction to Rubber Technology - Andrew Ciesielski 1999

Rapra Technology is the leading independent international organisation with over 80 years of experience providing technology, information and consultancy on all aspects of rubbers and plastics. The company has extensive processing, analytical and testing laboratory facilities and expertise, and produces a range of engineering and data management software products, and computerised knowledge-based systems. Rapra also publishes books, technical journals, reports, technological and business surveys, conference proceedings and trade directories. These publishing activities are supported by an Information Centre which maintains and develops the world's most comprehensive database of commercial and technical information on rubbers and plastics. Book jacket.

### **Compounding Precipitated Silica in**

**Elastomers** - Norman Hewitt 2007-04-24

This valuable guide to compounding elastomers with precipitated silica covers principles, properties, mixing, testing and formulations from a practical perspective. This handbook and reference manual will serve those who work on part design, elastomer formulation, manufacturing and applications of elastomers. Ample discussion of compound specifications adds to the usefulness of this book to practitioners. Comparisons of carbon black and silica compounds throughout the book allow readers to select the most suitable formulation for applications ranging from tires to electrical insulation to shoe soles. The author has over forty years of experience in the rubber industry highlighted by his 39 years at the PPG Rubber Research laboratories. A highlight of the book is the inclusion of studies conducted by the author which greatly adds to the richness of the contents.

### **Handbook of Fillers, Extenders, and**

**Diluents** - Michael Ash 2007

**High Performance Fillers 2007** - 2007

Progress in Rubber Nanocomposites - Sabu Thomas 2016-10-27

Progress in Rubber Nanocomposites provides an up-to-date review on the latest advances and developments in the field of rubber nanocomposites. It is intended to serve as a one-stop reference resource to showcase important research accomplishments in the area of rubber nanocomposites, with particular emphasis on the use of nanofillers. Chapters discuss major progress in the field and provide scope for further developments that will have an impact in the industrial research area. Global leaders and researchers from industry, academia, government, and private research institutions contribute valuable information. A one-stop reference relating to the processing and characterization of rubber nanocomposites

Presents the morphological, thermal, and mechanical properties that are discussed in detail. Contains key highlights in the form of dedicated chapters on interphase characterization, applications, and computer simulation.

Advances in Energy Materials and Environment Engineering - Chong Kok Keong 2022-10-19

This new book, *Advances in Energy Materials and Environment Engineering*, covers the timely issue of green applications of materials. It covers the diverse usages of carbon nanotubes for energy, for power, for the protection of the environment, and for new energy applications. The diverse topics in the volume include energy saving technologies, renewable energy, clean energy development, nuclear engineering and hydrogen energy, advanced power semiconductors, power systems and energy and much more. This timely book addresses the need of the hour and will prove to be valuable for environmentally conscious industry.

professionals, faculty and students, and researchers in materials science, engineering, and environment with interest in energy materials.

*Constitutive Models for Rubber*- J. Busfield  
2003-01-01

Recent developments in the modelling of rubber are collated in this volume, including not only stress-strain behaviour and the use of the large strain finite element method for simulation, but also fatigue, fracture, filler reinforcement, dynamic properties and the effects of ageing.

Fracture Mechanics and Statistical Mechanics of Reinforced Elastomeric Blends - Wolfgang Grellmann 2013-06-05

Elastomers are found in many applications ranging from technology to daily life applications for example in tires, drive systems, sealings and print rollers. Dynamical operation conditions put extremely high demands on the performance and stability of these materials and their elastic and flow properties can be easily adjusted by simple

manipulations on their elastic and viscous properties. However, the required service life suffers often from material damage as a result of wear processes such as abrasion and wear fatigue, mostly caused by crack formation and propagation. This book covers interdisciplinary research between physics, physical chemistry, material sciences and engineering of elastomers within the range from nanometres to millimetres and connects these aspects with the constitutive material properties. The different chapters describe reliable lifetime and durability predictions based on new fracture mechanical testing concepts and advanced material-theoretical methods which are finally implemented in the finite element method for structural simulations. The use of this approach allows a realistic description of complex geometrical and loading conditions which includes the peculiarities of the mechanical behaviour of elastomeric materials in detail. Furthermore, this approach demonstrates how

multi-scale research concepts provide an ambitious interdisciplinary challenge at the interface between engineering and natural sciences. This book covers the interests of academic researchers, graduate students and professionals working in polymer science, rubber and tire technology and in materials science at the interface of academic and industrial research.

**Mechanics of Composite and Multifunctional Materials, Volume 7** - Carter Ralph  
2015-10-30

Experimental Mechanics of Composite, Hybrid, and Multifunctional Materials, Volume 7 of the Proceedings of the 2015SEM Annual Conference & Exposition on Experimental and Applied Mechanics, the seventh volume of nine from the Conference, brings together contributions to this important area of research and engineering. The collection presents early findings and case studies on a wide range of areas, including: Multifunctional Materials

Hybrid Materials Novel Composites Nano- and Particle-Reinforced Composites Additive Manufacturing of Composites Digital Imaging of Composites Damage Detection Non-Destructive Evaluation Fatigue and Fracture of Composites Manufacturing and Joining of Composites Advanced Composites Applications

**Health and Safety in the Rubber Industry** - N. Chaiear 2001

This report takes a broad overview of the rubber industry and highlights the key concerns over safety that are currently being raised. The statistics on the incidence of accidents are reviewed. The rubber industry has been highlighted as having a higher rate of accidents than other similar industries. Measures that can be taken to avoid injury from machinery are discussed, including advice from the International Labour Organization on mill safety. The review is accompanied by around 400 abstracts from the Rapra Polymer Library database, to facilitate further reading on this

subject.

**Organic-Inorganic Hybrid Materials** - Jesús-María García- Martínez 2021-10-27

This book deals with one of the most attractive fields in material science and technology research. In fact, the concept of organic-inorganic hybrid materials is applied to a wide variety of approaches that include materials with inorganic and/or organic nature with respect to their matrices and/or dispersed phase. The present book compiles one editorial and eleven approaches to the topic, and intends to provide a transversal idea about what the field of the so-called organic-inorganic hybrid materials means in actual scientific scenarios. In any case, the role is pointed out of the interphase between the components as the critical aspect to consider, as a way to enhance and understand these components in order to design materials with "tailor-made" organized structures considering the increasing nano-, meso-, micro- and macro-scales.

Chemistry, Manufacture and Applications of Natural Rubber - Shinzo Kohjiya 2014-02-17

The growing demand for more sustainable materials has led to increased research on the properties of natural rubber. Chemistry, Manufacture and Applications of Natural Rubber summarizes this research and its significance for the industrial applications of natural rubber. Chapters in part one explore the properties and processing of natural rubber, including the biosynthesis of natural rubber in different rubber-producing species, chemical modification of natural rubber for improved performance, and the effect of strain-induced crystallization on the physical properties of natural rubber. Further chapters highlight hydrophobic and hydrophilic silica-filled cross-linked natural rubber and computer simulation of network formation in natural rubber. Part two focusses on applications of natural rubber, including eco-friendly bio-composites using natural rubber matrices and reinforcements, soft bio-

composites from natural rubber and marine products, natural rubber for the tire industry, the application of epoxidized natural rubber in pressure sensitive adhesives (PSAs), and the use of natural rubber for vibration isolation and earthquake protection of structures. Finally, chapters in part three consider environmental and safety issues associated with natural rubber, including improving the sustainable development of natural rubber, the recycling of natural and synthetic isoprene rubbers and of sulfur cross-linked natural rubber, and recent research on natural rubber latex allergy. Chemistry, Manufacture and Applications of Natural Rubber is a comprehensive resource for academics, chemists, chemical engineers, mechanical engineers, and other professionals in the rubber industry, as well as those industries, including automotive, civil, and medical engineering, using natural rubber products. An updated review with systematic and comprehensive coverage of natural rubbers

Covers a broad range of topics, including the chemistry, processing, sustainability, and applications of natural rubbers Coverage of the best international research, including key experts from Asia, the United States, South America, and Europe

Reinforcement of Rubber - Shinzo Kohjiya

2020-04-01

This book presents the most recent description of rubber reinforcement, focusing on the network-like structure formation of nanofiller in the rubber matrix under the presence of bound rubber. The resultant filler network is visualized by electron tomography applied to rubber. In the case of natural rubber, the self-reinforcement effect is uniquely functioning, and new template crystallization is suggested. Here, the crystallites are also believed to arrange themselves in a network-like manner. These results are of great use, particularly for engineers, in designing rubber reinforcement.

*Carbon- Cont ai ni ng Pol ymer Composi tes*

Mostafizur Rahaman 2018-10-05

This book discusses the methods synthesizing various carbon materials, like graphite, carbon blacks, carbon fibers, carbon nanotubes, and graphene. It also details different functionalization and modification processes used to improve the properties of these materials and composites. From a geometrical-structural point of view, it examines different properties of the composites, such as mechanical, electrical, dielectric, thermal, rheological, morphological, spectroscopic, electronic, optical, and toxic, and describes the effects of carbon types and their geometrical structure on the properties and applications of composites.

Enzyme-based Production of Nanocellulose from Soybean Hulls as a Green Filler for Rubber Compounding - Vamsi Krishna Bhadriraju 2020

Nanocellulose has been investigated for use in food packaging, biomedical applications, and electronics. This work attempted to isolate and

evaluate crystalline nanocellulose from soybean hulls in the form of cellulose nanofibrils (CNFs) as reinforcing fillers in natural rubber composites. CNFs and nanocrystalline cellulose (CNCs) have previously been derived from different types of lignocellulosic biomass. Previous work in this area used alkali pretreatments and acid hydrolysis to break down the complex network of cellulose, hemicellulose, and lignin present in plant cell walls. CNCs and CNFs have previously been isolated using high shear microfluidization, cryocrushing, freeze drying, and ultrafiltration. In this work, enzyme cocktails of carbohydrases produced from *Aspergillus niger* were used to hydrolyze the polysaccharides in soybean hull and soybean flour. Solids were separated from soluble sugars and other components after enzyme hydrolysis for 24 hours, and these washed solids were treated with sonication, blending, and homogenization to reduce the size of these solids. Particle size analysis showed that enzyme

hydrolysis did indeed generate nanoparticles, the majority of which were between 150-200 nm. The quantity of these insoluble nanoparticles was found to be small, however, relative to that of solids and seed coat fragments approximately 100-200 [micron]m in length. Further analysis with microscopy and SEM imaging revealed that the enzyme hydrolysis was able to cleave sclereid structures from the seed coat and breakdown soybean hull into fragments. Smaller particle size loading at the beginning of enzyme hydrolysis was found to release more sugar, so intermediate sizes were sieved in order to maximize solids recovery and minimize sugar release. These washed and mechanically treated solids were next mixed at alkaline pH (9.8-10) with natural rubber latex and oven dried overnight to create rubber composites. The resulting composites were masticated, vulcanized, and tensile tested in order to evaluate the efficacy of treated soybean hull solids as a reinforcing filler in natural rubber at

30 parts per hundred rubber (phr). Tensile testing results revealed that there was only an improvement of 3 MPa when compared to natural rubber, while rubber reinforced with carbon black improved tensile strength by a factor of 1.5. The results of this project showed that fillers derived through enzymatic hydrolysis and mechanical treatment of soybean hull marginally improve the tensile strength of natural rubber. It is suggested for future work that iterations of size reduction and filtration are performed to ensure that CNFs are the only solids in filler suspensions when compounded with natural rubber.

**Carbon Black** - Jean-Baptiste Donnet  
2018-05-04

The second edition of this reference provides comprehensive examinations of developments in the processing and applications of carbon black, including the use of new analytical tools such as scanning tunnelling microscopy, Fourier transform infrared spectroscopy and inverse gas

chromatography.; Completely rewritten and updated by numerous experts in the field to reflect the enormous growth of the field since the publication of the previous edition, Carbon Black: discusses the mechanism of carbon black formation based on recent advances such as the discovery of fullerenes; elucidates micro- and macrostructure morphology and other physical characteristics; outlines the fractal geometry of carbon black as a new approach to characterization; reviews the effect of carbon black on the electrical and thermal conductivity

of filled polymers; delineates the applications of carbon black in elastomers, plastics, and zero-graphic toners; and surveys possible health consequences of exposure to carbon black.; With over 1200 literature citations, tables, and figures, this resource is intended for physical, polymer, surface and colloid chemists; chemical and plastics engineers; spectroscopists; materials scientists; occupational safety and health physicians; and upper-level undergraduate and graduate students in these disciplines.