3rd International Conference on

POLYMERS AND COMPOSITES

ICPC

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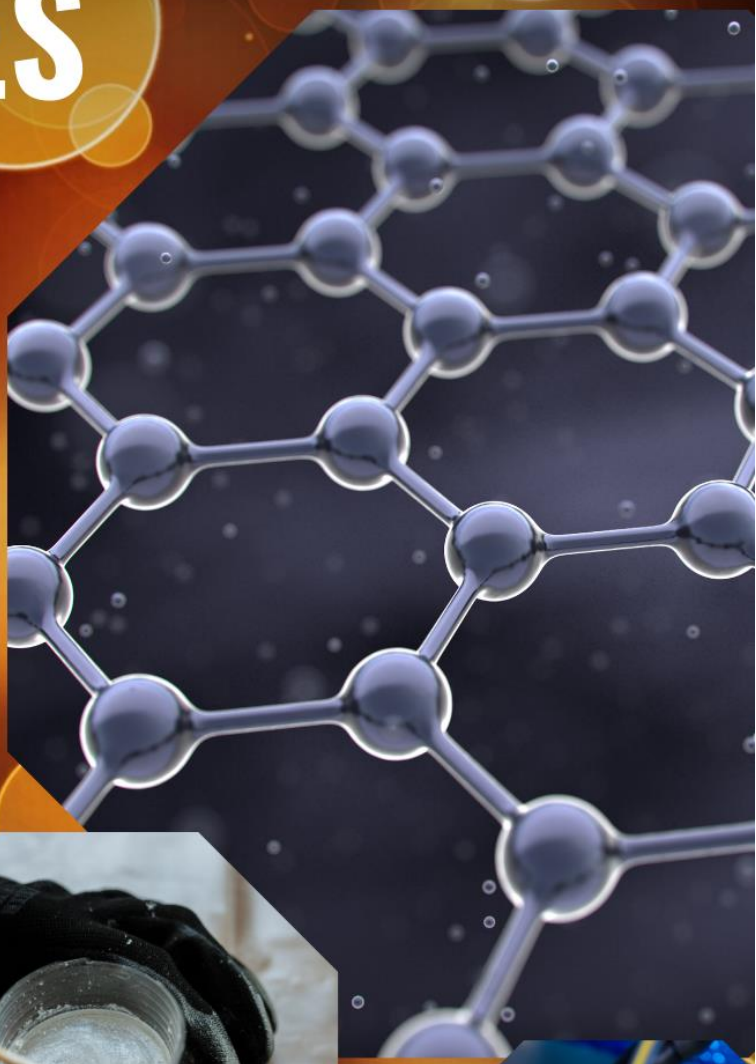

CONFERENCE PROCEEDINGS

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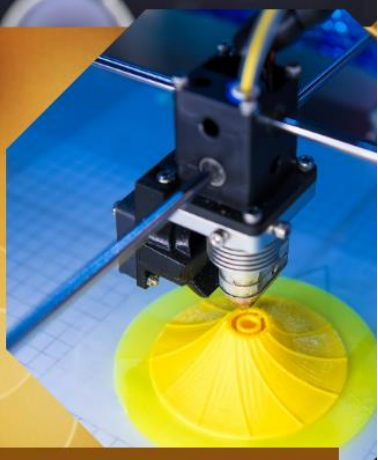

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MESSAGE FROM THE CHAIRMAN OF THE CONFERENCE

It is my pleasure to welcome all the participants to the 3rd International Conference on Polymers and Composites, organized by the Department of Materials, National Textile University, Faisalabad. I would like to thank the collaborator of this conference, University Teknologi Malaysia (UTM). I would like to thank the distinguished speakers and poster presenters who participated in this conference to make the event successful. I hope that this event will surely help the participants to gain more wisdom and knowledge from the speakers.

Dr Yasir Nawab

Dean, School of Engineering and Technology

National Textile University, Faisalabad-Pakistan

FOREWORD FROM THE CONFERENCE SECRETARY

It is a pleasure for me to thank the speakers, organizers, and participants of the 3rd International Conference on Polymers and Composites. The “Polymers and composites” is a promising field finding applications in every walk of life from disposable to durable, and cheap to high-value products. Various national and international speakers explored different domains of polymers and composites including polymer synthesis, 3d printing, hydrogels, aerogels, polymer systems, sandwich composites, advanced composites, nanocomposites, sustainable developments, functional materials, etc.

The purpose of this conference is to international recognition of our department, making it a world-class institute in polymers and composite materials. I am convinced that this event will serve as a platform for strengthening our relationships not only in knowledge sharing and collaborations within the research community. It is my aspiration that this event will be a base for the growth of new ideas towards a better tomorrow.

Dr. Khubab Shaker

Chairman, Department of Materials

National Textile University, Faisalabad-Pakistan

KEYNOTE SPEAKERS

Prof. Dr. Rehan Umar
Khalifa University of Science and Technology, UAE

Prof. Dr. Mat Uzir Wahit
Universiti Teknologi Malaysia, Malaysia

Prof. Monica Ferraris
Politecnico di Torino, Italy

Dr. Hugh Gong
University of Manchester, United Kingdom

Prof. Valentina Casalegno
Politecnico di Torino, Italy

Keynote Talks

Hybrid Thermoplastic Composites based on Liquid Thermoplastic Resin and Carbon/Glass Reinforcements

Prof. Rehan Umar, Khalifa University, UAE

Hybrid polymer nanocomposites for high voltage insulation materials

Prof. Mat Uzir Wahit, Universiti Teknologi, Malaysia

Etching of Carbon Fiber-Reinforced Plastics to Increase Their Joint Strength

Prof. Monica Ferraris, Politecnico di Torino, Italy

Integration and joining of CMCs

Prof. Valentina Casalegno, Politecnico di Torino, Italy

Composites of Recycled Carbon Fibers

Dr R Hugh Gong, University of Manchester, UK

HYBRID THERMOPLASTIC COMPOSITES BASED ON LIQUID THERMOPLASTIC RESIN AND CARBON/GLASS REINFORCEMENTS

Rehan Umar

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Fiber reinforced polymer composites (FRPC) have become significantly popular in multiple structural applications over past few decades due to their unique properties. Hybridization is one the most effective techniques to avoid catastrophic failure in high-performance carbon fiber reinforced polymer composites (CFRPs). In ongoing efforts to move towards sustainable composites, we have used infusible thermoplastic resin; Elium® to manufacture different hybrid composites to investigate the microstructural changes and mechanical performance of thermoplastic composites. We have characterized the composites using micro-CT, flexural, tensile and SEM analysis. The tensile strength and Young's modulus of the hybrid composites showed 155% and 380% increases, respectively, compared to the pristine GFRP specimens. Whereas the tensile strain of the hybrid specimen having different stacking sequence was 37% higher than that of the CFRP specimens. Similar flexural results were observed.

Keywords: Fibers, polymers, composites

HYBRID POLYMER NANOCOMPOSITES FOR HIGH VOLTAGE APPLICATIONS

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The study proposes hybridization of polymeric-based nanocomposite as an insulating material, thus improving its properties by reducing agglomeration of nanofillers. The hybridization process involves surface treatment and compatibilizers, enhancing the dispersion of nanofillers in small amounts less than one weight percent. This leads to enhanced dielectric, thermal, and mechanical properties. The crosslinked polyethylene/layered double hydroxide-aluminium oxide (XLPE/LDHs-Al2O3) nanocomposite, prepared with sodium dodecylsufate (SDS) and silane, showed significant improvement in dielectric, thermal, and mechanical properties. It was found that the value of partial discharge magnitude improvement went down to 47.8% and AC breakdown strength increased by 15.6% as compared to pure XLPE. The mechanical properties were enhanced by 14.4%, 31.7%, and 23% for tensile strength, Young's modulus, and elongation at break, respectively. Hence, the hybridization of nanofillers opens a new perspective in developing insulating material based on XLPE nanocomposite

Keywords: Crosslinked polyethylene, Hybrid filler, Dielectric properties, Mechanical properties, Thermal properties, Hybrid nanocomposite

ETCHING OF CARBON FIBER-REINFORCED PLASTICS TO INCREASE THEIR JOINT STRENGTH

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An original method to increase the mechanical strength of adhesively joined carbon fiber-reinforced plastics (CFRP) by etching is presented, based on chemical etching of the CFRP surface. Etched composites are joined by adhesives and their cross section is observed by FESEM. Etching of CFRP is aimed to obtain a ‘‘brush’’-like composite to be infiltrated by the adhesive, giving a fiber-reinforced, stronger composite joint. This method gave a 100% increase in the lap shear strength for the adhesively joined etched CFRP, compared to the non-etched ones.

Keywords: CMCs, CFRPs, Joining, FESEM

INTEGRATION AND JOINING OF CMCS

Prof. Valentina Casalegno

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This paper presents and analyzes innovations in the development, processing, and characterization of CMC-based joined components achieved by the GLANCE (Glasses, Ceramics and Composites) research group at Politecnico di Torino, Italy. These components, designed for various applications, undergo thorough fabrication and characterization under simulated working conditions. Recent findings are summarized, focusing on the integration of sophisticated interface designs, diverse joining materials/technologies, selective removal of composite surface matrices, laser structuring, and mechanical machining of composite/metal interfaces. This discussion includes a comparative analysis against existing solutions, emphasizing the advancements and potential impact of these novel techniques and approaches.

Keywords: Glass, ceramics, composites

COMPOSITES OF RECYCLED CARBON FIBERS

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The talk will focus on ways to maximise the value of recycled carbon fibres (rCF). Recycled carbon fibres are usually in short staple fibre form with random orientation and high fibre length variation. They are mostly used for making nonwoven matts as reinforcement of composites. The performance of the resulting composite is much lower than virgin carbon fibre composites which have controlled fibre alignment. Developments have been made recently to transform short / random rCF into products of continuous form with improved fibre alignment. These continuous rCF products can then be used in ways similar to virgin carbon filaments to produce composites of improved performance.

Keywords: Recycling, carbon fibres

INSIGHTS INTO THE THERMOCATALYTIC DEGRADATION OF WASTE POLYSTYRENE WITH A FOCUS ON LIQUID PRODUCT YIELD

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Polystyrene (PS) is a widely used plastic with various applications, but its disposal poses environmental threats due to toxic gases produced during landfill or incineration. Recycling is vital to mitigate these threats, with tertiary recycling methods being preferred. Heterogeneous catalysts play a role in PS degradation, including solid acid and base catalysts, conductors, semiconductors, and insulators. Solvents can also improve the degradation process by reducing viscosity, enhancing heat transfer, and increasing liquid yield. The temperature and reaction time also influence the degradation process, impacting the yield of various products, such as styrene monomer, low molecular weight hydrocarbons, and gases. Shorter reaction times favor styrene monomer, while longer times favor low molecular weight hydrocarbons.

Additives like acids and bases modify the thermal degradation of PS, affecting product yields and pathways. When PS is mixed with other plastics like HDPE, LDPE, PVC, PET, PP, or biomass, the degradation environment changes, leading to different product compositions. Different reactors, such as fixed bed, fluidized bed, conical spouted bed, and free fall reactors, are used for large-scale plastic recycling, each with its pros and cons.

Keywords: Polystyrene; Styrene monomer; Degradation; Thermo-catalytic process; Mechanism

REVOLUTIONIZING FOOD PACKAGING: NANOCELLULOSE REINFORCED STARCH NANOCOMPOSITE BIOPLASTICS FOR A GREENER TOMORROW

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In recent years, the environmental impact of plastic-based food packaging has led to a pressing need for sustainable alternatives. Starch, as a biodegradable biopolymer, has emerged as a promising candidate for replacing traditional non-biodegradable plastics. However, the inherent limitations of starch, including the need for processing and plasticization to become thermoplastic starch (TPS), have necessitated further exploration. Various factors, such as the type and quantity of plasticizers and mixing speeds, play pivotal roles in TPS preparation. Nevertheless, the properties of TPS still fall short of those of conventional plastics. To address this, researchers have turned to the incorporation of microcellulose or nanocellulose, reinforcing TPS through methods like melt mixing, extrusion, and internal mixing. This review compiles studies examining the influence of plasticizers and the significance of different cellulosic fillers in enhancing the properties of TPS, with a focus on large-scale production. It also explores the potential applications of these materials, such as in food packaging and biomedical contexts, offering an eco-friendly alternative. By harnessing the remarkable properties of nanocellulose, such as high strength, renewability, and biodegradability, these TPS composites demonstrate improved mechanical, barrier, and thermal characteristics. This review provides a comprehensive overview of the developments in nanocellulose fiber-reinforced starch biopolymer composites, highlighting their promise in addressing pressing environmental concerns related to non-biodegradable plastics and offering insights into their various applications in different fields.

Keywords: Thermoplastic starch, nanocellulose, biodegradable

DELAMINATION LOCALIZATION IN SMART LAMINATED COMPOSITES: A TRANSITION FROM CONVENTIONAL TO CONTEMPORARY APPROACHES

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This talk will begin from the importance of Nondestructive Testing and Evaluation (NDT & E) and Structural Health Monitoring (SHM) of Laminated Composites. An overview of general NDT & E will be provided with their limitations for in-situ SHM of critical assists. The vibration-based methods for SHM will be discussed in details with laminations of guided wave-based methods and acoustic emission-based approaches. The talk will discuss the importance of low-frequency structural vibration for in-situ SHM and the associated limitations in terms in delamination localization and quantification. The conventional approaches of delamination detection and localization using signal processing will be discussed followed by their practical limitation for in-situ applications. An introduction of different frameworks of artificial intelligence will be provided with the advantages and disadvantages of each framework. The talk will include example problems from the author's research work on the use of AI for the delamination assessment in smart composite laminates. The talk will be concluded with major challenges in the area of AI for NDT & E and SHM of laminated composites.

Keywords: Nondestructive, Delamination, composites

DEVELOPMENT OF NOVEL BIOPOLYMER COMPOSITES FOR STRUCTURAL APPLICATIONS

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Biocomposites exhibit properties like many petrochemical-based polymer composites. They have the potential to be used in the automotive and decking industries and as biodegradable packaging. However, the high cost and poor mechanical and thermal properties have restricted their widespread use. Several technical issues need to be addressed before bio-composites can be widely used. This keynote talk will focus on the thermal, mechanical, and morphological properties of the biopolymer composites using DSC, UTM, DMA, and hot-stage microscopy. was investigated during the processing of biopolymers using copolymers.

Keywords: Bio-composites, sustainability, biodegradable materials

IMPACT OF PLASMA SURFACE MODIFICATION ON FILTRATION PERFORMANCE OF NANOCOMPOSITE FILTER MATERIAL

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Low pressure drop is highly desirable in a filter material which are especially being used for respiratory protection. Surface activation plays an important role to enhance the particle capturing mechanism in a filter material. In this study, a nanocomposite filter material was developed by using the combination of polypropylene (PP) nonwoven layers and chitosan nanofibres (CSNF) with variable coating time (h) during the electrospinning process. Low pressure plasma surface treatment was performed on the outer surface of all the developed samples to analyse the impact of surface activation on filtration performance. Filtration performance characterisation was performed to determine the filtration efficiency (%), pressure drop (Pa), and quality factor (Q), before and after the surface treatment. Results illustrated that the maximum values of filtration efficiency and quality factor achieved were 99.99% and 0.068 respectively. Furthermore, the lowest obtained value of the pressure drop was 16.12 Pa. All the surface treated nanocomposite samples showed higher filtration efficiency and quality factor compared to untreated samples due to more effective particle capturing mechanism. However, results showed no significant impact on pressure drop value as a comparison. In conclusion, low pressure plasma surface modification with a small amount of nanofibers coating can produce a nanocomposite filter material for respiratory applications with enhanced filtration performance especially in pressure drop evaluation.

Keywords: Nanocomposite, Filtration performance, Surface activation, Low pressure plasma, Nanofibres, Respiratory protection

ADVANCING BATTERY THERMAL MANAGEMENT THROUGH POLYMER-BASED COMPOSITE MATERIALS VIA 3D PRINTING AND ADDITIVE MANUFACTURING

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The fundamental challenges for Electric Vehicles (EVs) and hybrid Electric Vehicles (HEVs) are finding efficient batteries that can help with fast charging, maximum mileage, and high-performance driving. Lithium Ion Batteries (LIBs) are the most widely used batteries for EVs however, their electrochemistry is quite complex, and they generate a large amount of heat during charging and discharging, which impacts the overall performance of the battery. An optimised Battery Thermal Management System (BTMS) solution may dramatically increase battery performance, safety, and reliability while extending battery life. Using composite materials for BTMS thermal management is an alternative to air- and liquid-cooled systems. Composite of different can control the temperature of the electrochemical energy storage systems (ESS) by utilising their high heat capacity to absorb significant amounts of energy while changing phases at steady temperatures. The study delves into an in-depth exploration of diverse polymer composites tailored for 3D printing applications, specifically geared towards developing battery casings for BTMS. Utilizing the Ultimaker S3 printer, we scrutinize the mechanical and structural attributes of eight distinct materials: Polylactic Acid (PLA), Acrylonitrile Butadiene Styrene (ABS), Polyethylene Terephthalate Glycol (PETG), Polyvinyl Alcohol (PVA), PLA/Cu, PLA/CF, Stainless Steel/PLA, and Stainless Steel/ PLA. Through the variation of infill rates and the incorporation of diverse materials into the PLA base filament, our study aims to enhance the thermal performance of battery casings crucial for efficient thermal management systems. Findings indicate that natural PVA and PLA/CF exhibit exceptional thermal properties, surpassing conventional polymers like PLA, PETG, and ABS, positioning them as promising candidates for advanced thermal management applications. Including copper in PLA and stainless steel in PLA demonstrates marked improvements in thermal conductivity and structural integrity. Unexpectedly, the stainless steel/8PLA blend also showcases significant enhancements, making it a viable option for thermal management within battery systems.

Keywords: Phase change materials, 3D printing, Polymer heat exchange, lithium-ion battery, Battery thermal management system, Composite materials, Fused Filament fabrication.

ENHANCING THE MECHANICAL PROPERTIES OF BIODEGRADABLE FILMS DEVELOPED FROM COCONUT HUSK USING PLASTICIZERS

Abdul Mueez Ahmad, Anas Afzal

University of Agriculture Faisalabad

The demand for Packaged Food has increased tremendously over the last few years. The food is usually packaged in Non-Biodegradable packaging usually made from materials like polyethylene, Polyolefin, Polyesters, etc. These materials cause a lot of pollution when released into the environment. This has led the scientific community to search for Natural Biodegradable alternatives for the Packaging of Food. Food processing waste has grabbed the attention of scientists to develop Biodegradable material due to the similarity in film-forming properties with petrochemicals, lower cost, and natural biodegradability. The poor mechanical performance of these bioplastics is a great barrier to their practical application. In Pakistan about 12,250 Tons of Coconut are produced every year about 50% of this represents coconut husk which is usually discarded. This coconut husk is composed of about 40% Cellulose, 20% Hemicellulose, and 30% lignin. In this research, Cellulose was extracted from the Coconut husk, and Biodegradable films were made using Glycerol, Sorbitol, and Xylitol as plasticizers in 20, 30, and 40% concentrations to find appropriate concentrations of suitable plasticizer. The results showed that the Elongation percentage of the films was increased with plasticizer concentration while their tensile strength was decreased. Among the various types and concentrations of plasticizers, it was found that the films with 20% xylitol concentration had better mechanical properties. At the same concentrations mechanical properties of films with glycerol and sorbitol were poor. Thus, Xylitol can be used to enhance the mechanical properties of Biodegradable films.

Keywords: Biodegradable, coconut husk, plasticizers

PROMOTING AN ECO-FRIENDLY ENVIRONMENT THROUGH THE UTILIZATION OF NATURAL MATERIALS POSSESSING SUPERIOR SURFACTANT QUALITIES COMPARED TO THEIR SYNTHETIC COUNTERPARTS

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The plant extract was found to be rich with surfactant properties. The comparative study between synthetic and natural surfactant was carried out using spectrophotometry, and conductometric measurement. The natural surfactant plant gave CMC values 4.4×10 -4 M. It is the point where their monomer aggregates to form micelles, which are far below the CMC point of most of the synthetic surfactants. The role of temperature was also monitored in comparison to the synthetic surfactants. The pH was used to find the nature of surfactants and number of replaceable protons in the system. The surfactant interaction properties were monitored against a variety of dyes cationic (CTAB), and anionic (methylene blue and neutral red). The interactions were monitored from pre- to post micellar concentrations of both natural and synthetic surfactants. The change in concentration of the surfactant led to the change in interaction behaviour. Wide range of temperatures were selected to monitor the behaviour and interactions of the natural and synthetic surfactants as these interactions are temperature dependent and found to be favourable at lower temperatures.

The self-degradation was observed at ambient temperature and in the dark both in aerobic and anaerobic conditions. Based on its behavior and degradation properties, the proposed natural surfactant is a cheap and good alternative to the synthetic surfactants. These natural surfactants were found to have surfactant properties and even efficient from synthetic counterparts and biodegradable thus environmentally friendly. Moreover, the natural surfactant helps to degrade many environmentally toxin dyes which are even non degradable in fenton presence.

Keywords: Environment, interactions, natural material

MACHINE LEARNING-BASED STRUCTURAL HEALTH MONITORING OF LAMINATED COMPOSITE STRUCTURES

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Laminated composites possessing high specific strength and tailored engineering properties are increasingly utilized in various industries such as aerospace, automotive, civil, and marine. However, due to the orthotropic nature of laminated composites, they are prone to complex failure modes. Therefore, it is imperative to perform early damage detection in composite structures to prevent catastrophic failure. Structural health monitoring (SHM) techniques provide a comprehensive solution for damage detection of laminated composites. Additionally, with the advancement of intelligent computational methods such as machine learning, the SHM process is transformed into data-driven approaches. Therefore, this research proposed a convolutional autoencoder (CAE) based machine learning model for SHM of laminated composite structures. The proposed method is validated on vibrational data obtained from carbon fiber-reinforced polymer (CFRP) composites. The raw vibrational signals are pre-processed through empirical mode decomposition to reduce the effect of noise. Correlation analysis is performed to extract the highly correlated intrinsic mode functions (IMFs) that were transformed into time-frequency scalograms using the continuous wavelet transform (CWT). The CAE model is trained on the scalogram images to recognize features for the three health states of the composites: healthy (H), delamination-1 (D1), and delamination-2 (D2). The trained CAE model is then validated on the unseen data to evaluate the model's generalization capability. In addition, accuracy, precision, recall, and F1-score are used as the evaluation metrics to check the performance of the proposed machine learning model. The results demonstrated that the proposed approach is beneficial for SHM of laminated composite structures.

Keywords: Laminated composites, structural health monitoring, composite structures, machine learning

SURFACE MODIFICATION OF POLYETHER ETHER KETONE (PEEK) USING DIAZONIUM SALT FOR ENHANCED SURFACE PROPERTIES

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Polyether ether ketone (PEEK) stands as a highly promising thermoplastic with vast potential for applications in demanding industries such as biomedical, surgical, pharmaceuticals, seals, valves, bearings, and various components of pumps. PEEK's remarkable chemical, mechanical, thermal, and water resistance characteristics have enabled its widespread adoption in diverse commercial applications. This study delves into the surface modification of semi-crystalline PEEK through a strategic application of Diazonium salt, specifically Benzene diazonium chloride, under carefully controlled conditions. Diazonium salt adlayers possess the capability to alter the properties of metal, semiconductor, polymer, and other insulating material surfaces, affecting key attributes including wetting behavior, adhesion, dispersion, chemical sensing, controlled cell adhesion, resistance to protein adsorption, and mitigation of bacteria fouling. The investigation primarily focuses on assessing the changes in wetting and thermal properties of PEEK following treatment with diazonium salt. Fourier-transform infrared spectroscopy (FTIR) analysis was conducted both before and after subjecting the polymer film to diazonium salt exposure, unequivocally confirming the successful attachment of the -N≡N2+ functional group. Our findings, as demonstrated through water contact angle measurements and Thermogravimetric Analysis (TGA), elucidate the influence of diazonium salt on the polymer's surface characteristics. The wettability of the polymeric sheets exhibited a reduction compared to the pristine polymer, while thermal analysis highlighted a degree of reduced stability in the treated polymer relative to the untreated counterpart, albeit within acceptable limits. This research contributes valuable insights into the controlled modification of PEEK surfaces through diazonium salt, offering a pathway to tailor surface properties for enhanced performance across a wide spectrum of applications, including those demanding advanced wetting behavior and thermal stability.

Keywords: PEEK, DIAZONIUM SALT, WETTABILITY

FLEXIBLE RUBBER BASED CONDUCTIVE NANOCOMPOSITE FOR ACHIEVING ENHANCED ELECTROMAGNETIC SHIELDING PROPERTIES

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The chemical oxidative method was used for the polymerization of the polyaniline (PANI) using APS as an oxidant and formic acid as a dopant and co-precipitation method was used for the precipitation of nickel ferrites (NiFe). Polyaniline used to impart conductivity and nickel ferrites for magnetic permeability to achieve high EMI shielding. Seven different composites were made varying their composition and tested for various properties like morphology, DC conductivity, EMI shielding etc. In SEM analysis it was discovered that PANI and NiFe particles dispersed in NBR rubbers uniformly. DC conductivity was also rised to 286 S/cm from 10-7 S/cm. XRD and particle size analysis used to conform the successful fabrication of PANI and NiFe and their particle size respectively. DSC confirmed that the melting point downed by the addition of PANI and NiFe in NBR rubber. EMI shielding of almost 52 dB was achieved while pure rubber provides only 1-2 dB. Keywords: Nickel ferrites; Polyaniline; solution polymerization; EMI shielding; Nanocomposites

Keywords: Nickel ferrites; Polyaniline; solution polymerization; EMI shielding; Nanocomposites

NATURAL FIBERS AND THEIR PROPERTIES FOR COMPOSITES REINFORCEMENT

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Due to environmental concerns, natural fiber development is essential, and their utilization has recently attracted more attention. The use of jute, hemp, linen, sisal, and banana fibers in textile production is widespread around the world. Additionally, these fibers are widely accessible in many countries, including Pakistan, India, China, Turkey, and the United States. The objective of this study is to compare the physio-mechanical characteristics of the aforementioned natural fibers. All of these fibers were obtained locally. Scanning electron microscopy was used to examine the surface morphology of these natural fibers, and the results revealed that banana and sisal fibers are hollow in comparison to other fibers. A single fiber tensile testing apparatus was used to evaluate the mechanical characteristics. The highest breaking strength and %elongation were demonstrated by banana and sisal fibers, respectively. Fourier transform infrared spectroscopy was used to investigate the functional groups of these natural fibers. Differential calorimetry spectroscopy and thermogravimetric analysis were used to investigate their thermal behavior. Energy Dispersive X- Ray Analysis and Raman analysis were also carried out to ascertain the chemical composition. Keywords: Natural fibers, Mechanical properties, SEM, FTIR, TGA, DSC, EDX, Raman analysis ACKNOWLEDGMENTS Authors would like to express their gratitude and appreciation to Bursa Technology Coordination and R&D Center (BUTEKOM) for their valuable support in performing the tests and analysis.

Keywords: Natural fibers, composites

HYDROTHERMAL AGING OF THREE-PHASE COMPOSITE

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The three-phase composite is developed. The manufacturing process of this three-phase composite involved simple GFRC and incorporating TiO2 nanoparticles at 1 wt.% and 4 wt.%, as well as CaCO3 nanoparticles at 1 wt.% and 4 wt.%. Moreover, a combination of 4 wt.% of both TiO2 and CaCO3 nanoparticles was used. Glass fibers were included as a reinforcement, while YD 128 Epoxy and TH 7301 Curing Agent served as the matrix phase. The fabrication was carried out using the Hand Lay-up method. Six different types of samples were fabricated by changing the weight percentages of TiO2 and CaCO3 nanoparticles. The hydrothermal aging effect on mechanical performance was analyzed. The samples were exposed to hydrothermal aging in 100% humidity and a temperature of 70°C for periods of 8 hours and a duration of 15 days. The samples were subjected to testing both before and after hydrothermal aging to find the one that demonstrated superior performance in hydrothermal aging environments and showed high mechanical properties. Hardness testing, tensile testing, short beam shear testing and Charpy testing were conducted for this purpose. The incorporation of TiO2 and CaCO3 nanoparticles in GFRC showed mixed effects on the mechanical properties and resistance to hydrothermal aging. GFRC with TiO2 1 wt.% demonstrated superior hardness and improved tensile properties after hydrothermal aging. However, the simple GFRC without nanoparticles exhibited higher interlaminar shear strength and impact resistance. These results contribute to the understanding of composite materials and provide insights into their application in hydrothermal aging environments.

Keywords: Aging, fillers, three-phase composite, glass fibre reinforcement, epoxy, hydrothermal aging

DEVELOPMENT AND CHARACTERIZATION OF BARREL WASH WASTE AS AN UPCYCLED RAW MATERIAL FOR THE AUTOMOTIVE AND ELECTRONIC INDUSTRIES.

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Plastic waste management is a global issue, and plastic industries are increasingly looking for sustainable solutions to reduce their environmental impact. One significant aspect of this challenge is the management of plastic waste, particularly the in-house waste of plastic processing industries. One major waste product of the plastic processing industries is the barrel wash from mold or raw material changes on an injection molding machine. In this work an upcycled raw material source for the local automotive and electronic industries in Pakistan was developed from the barrel wash waste of injection molding machines in Pakistan. The barrel wash system selected for this work was an Acrylonitrile Butadiene Styrene/Polycarbonate (ABS/PC) based blend. The barrel wash waste was upcycled through a multi-step polymer processing route and by utilizing nanofillers. The upcycled barrel wash sample was characterized using Fourier transform infrared spectroscopy (FTIR), thermogravimetric analysis (TGA), differential scanning calorimetry (DSC), universal testing machine (UTM), density, and hardness analysis. The technical characterization results were then compared to the technical data sheets (TDS) of local market samples for techno-economic feasibility of the upcycled products in the automotive and electronic industries.

Keywords: Upcycling, Barrel Wash, Automotive, Electronic, Nanofillers.

ECO-FRIENDLY SHOPPING BAGS: TECHNO-ECONOMIC-SOCIAL FEASIBILITY OF BIO-DEGRADABLE AND SUSTAINABLE ALTERNATIVES TO PE BAGS FOR REDUCING WASTE

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Plastic bags are one of the most widely utilized single use products in the world. From groceries of the supermarket to buying meat from the butcher shop, one must opt for the shopping bag. Shopping bags have now started to become a huge solid waste problem all over the world. In this study, a feasibility study was carried out to reduce the use of one-time shopping by replacing them with more durable, sustainable as well as bio-degradable shopping bags. Alternatives include reusable Biodegradable bags, Jute bags, Mesh bags, Recycled bags, Non-woven PP bags, Cotton bags, and High shine laminated bags. The study involves the development of techno-economic-feasibility analysis by examining the environmental, social and financial impact of traditional shopping bags, highlighting the harmful effects on ecosystems, marine life, and human health. The technical analysis included the thermal, mechanical, and environmental analysis The economic analysis of the feasibility study was based on the estimation of prices on the financial impact of each alternative. The social aspect was covered by conducting an initial stage survey to gather public information about the use of various alternatives. The technical, economical, and social aspects were then combined to develop the feasibility analysis to suggest the best shopping bag alternatives.

Keywords: Plastic bags, Shopping bag, Reusable bags, Biodegradable bags, Recycled bags, Ecosystems, Feasibility study

MARITIME APPLICATIONS OF FIBRE REINFORCED POLYMER COMPOSITES

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This presentation details the use of fibre reinforced polymer matrix (FRP) composites in maritime applications as part of the Strength in Places project, 'Decarbonisation of Maritime Transportation'. Three research areas are considered: (i) modelling and assessing impact damage in composites marine structures, (ii) hybrid composite-metal laminates for bolted joints, and (iii) application of artificial intelligence in the failure prediction of composite materials. In the first study, an in-house intralaminar damage model, capturing both fibre-dominated and matrix-dominated damage, along with an available interlaminar cohesive model are used within an explicit dynamic finite element formulation for modelling low velocity impact (LVI) damage and compression-after-impact (CAI) performance of composite maritime structures. In the second study, a modified transverse crack tensile (mTCT) test method is extended for the calculation of mode II fracture toughness. A parametric study is conducted using finite element analysis to determine the design parameters. Mechanical tests and digital image correlation (DIC) technique are then used to show that the proposed test setup can be extended to composite-metal laminates. In the third study, a data-driven probability embedded failure criterion is used for the failure prediction of unidirectional FRP composite materials under biaxial stress states based on micromechanical modelling and artificial neural networks (ANNs). High-fidelity 3D representative volume element (RVE) models are used for the generation of failure data sets. Keywords: Finite element analysis, Fibre reinforced polymer campsites, Impact behaviour, Artificial neural networks, Hybrid composite-metal laminates. ACKNOWLEDGMENTS Belfast Maritime Consortium UKRI Strength in Places project, 'Decarbonisation of Maritime Transportation: A return to Commercial Sailing' led by Artemis Technologies, Project no. 107138.

Keywords: Finite element analysis, Fibre reinforced polymer campsites, Impact behaviour, Artificial neural networks, Hybrid composite-metal laminates

ROLE OF ANTI-REVERSION AGENT(S) IN RUBBER COMPOUNDING

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The degradation of rubber compound(s) &/or product(s), commonly referred to as “reversion”, under the influence of heat as well as the severe end-use conditions poses difficulties for a rubber compounder to meet with the ever-increasing demands of the market. It has been a major concern for the rubber industry & has to be overcome in order to increase the service life of the product. This is where the role of anti-reversion agents is quite crucial not only to avoid the degradation during the prolonged cure cycle of thick cross-sectional products, like agriculture & OTR (off the road) tyres, but also during the severe end-use of the product where it gets exposed to extreme stresses of various kinds. So we will not only discuss about the scope of various anti-reversion agents but will also have a look, by means of a truly practical data, at the effectiveness of various such materials in order to choose the best one as per the application requirements.

Keywords: Rubber Compounding, Anti-Reversion Agents, Sustainability

DESIGN AND MANUFACTURE OF THREE-DIMENSIONAL UHMWPE/RAMIE HYBRIDIZED FABRIC FOR ANTI-SLIP CHAINS

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Traditional anti-slip tyre chains have several drawbacks such as bulkiness, loud noise, and susceptibility to tyre damage, which can ultimately cause damage to the vehicle and discomfort to passengers during use. A product which can overcome the above shortcomings is urgently needed, which can also help to improve the anti-slipping performance of vehicles. This research aims to develop a new kind of tyre chain with the advantage of lightweight, low tyre damage, low noise and passengers' comfort. A cloth-made tyre anti-slipping chain based on 3D woven fabric structure is proposed in this research. High performance fiber UHMWPE was used to supply high wear resistance to the tyre chain. High moisture absorption fiber Ramie was selected to absorb the water film in the snow or ice road, which can transform the wetting friction to dry friction between the wire and snowy road. The UHMWPE and ramie were hybridized in 3D woven structure to provide the wire chain excellent anti-slipping and wear resistance properties. The results of this research provide a new method of wire anti-slip mechanism with higher anti-slip performance, which has important practical value.

Keywords: Ultra-High Molecular Weight Polyethylene fiber; Three dimensional woven fabric; Friction coefficient; Wear resistance; Anti-slip

DESIGN AND DEVELOPMENT OF NATURAL LATEX-BASED DIP COATING FOR SYNTHETIC YARN USED IN AUTOMOTIVE TYRES

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In this work, a natural latex based RFL dip coating was developed for polyester yarns used in automotive tyres. A natural latex based RFL dip coating was used to deposit a thin coating over polyethylene terephthalate (PET) yarn to boost its adhesion with rubber compound in a tyre and compared its mechanical and thermal properties with two different silane coated yarns/rubber composites. In our study, pretreatment of polyester yarns was done by using an alkaline solution to improve the interface and then applied RFL dip coating and silane coating to enhance adhesion between yarns and rubber matrix. Afterwards, these treated yarns rubber composite prepared by using hydraulic compression moulding machine at 1800C temperature and 2000 psi pressure. FTIR and TGA tests were done to characterize functionality and chemical composition of modified coated, uncoated yarns, silane coatings, and rubber compound. The Zeta sizer test was done to mention the size of ZnO nanoparticles. Hardness strength of all samples was also determined by using Shore A Durometer. The tensile strength and adhesion properties of uncoated and coated yarns were determined by universal testing machine (UTM). Adhesion properties were analysed by yarns Pull-out test. The adhesion strength of natural latex based RFL dip coating was higher than silane dip coating.

Keywords: RFL dip coating, automotive tyres, Silane dip coating, Rubber compound Adhesion properties, Braiding

DEVELOPMENT OF A MOISTURE REACTIVE POLYURETHANE BASED LAMINATING ADHESIVE

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Reactive hot-melt polyurethane adhesive (RHMPA) is a polyurethane (PU) adhesive that cures by reacting with ambient moisture after application. An isocyanate-terminated prepolymer of PU makes up the majority of it. PTMG, 1,4-butanediol, and 4,4'-diphenylmethane diisocyanate were used in a two-step bulk polymerization process to successfully synthesize two series of poly (tetramethylene glycol) (PTMG) containing RHMP. Sufficient amount of (DMDEE) Bis (2-morpholinoethyl Ether) were also added as catalyst. For these series (PTMG), a variety of molecular weights and hard segment polymerization intensities are offered. Since conventional adhesives are solvent-based, the key goal is to produce polyurethane adhesive that is moisture-based. It was discovered that when the chain extender concentration increased, RHMPA's mechanical characteristics, and adhesion qualities significantly improved. The RHMPA film was characterized by Fourier transform infrared spectroscopy (FTIR), differential scanning calorimetry (DSC), thermal mechanical analysis (TMA), and tensile tests to analyze its structure and properties.

Keywords: Reactive hot melt adhesive, Polyurethane, Bulk polymerization, Chain extender, FTIR, TMA, DSC, Tensile test

SYNTHESIS & CHARACTERIZATION OF BIODEGRADABLE FILM FOR ACTIVE FOOD PACKAGING APPLICATIONS

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Composite biodegradable films, consisting of starch, chitosan, and PVP reinforced with Napier Grass, were created using a solution casting method. The chitosan content ranged from 20% to 80% while keeping starch and PVP constant. The starch content varied from 20% to 80% while maintaining chitosan and PVP constant. PVP content also ranged from 20% to 80% while keeping starch and chitosan constant. The optimal Napier Grass loading remained at 20% (w/w). The addition of Napier Grass significantly enhanced tensile strength but reduced the elongation at break. Thermo-gravimetric analysis confirmed improved thermal stability. Fourier transform infrared spectroscopy was employed for structural characterization, and scanning electron microscopy showed a satisfactory homogenization of starch, chitosan, PVP, and Napier Grass. The water uptake of the final composites outperformed native chitosan films. These developed films demonstrated a satisfactory degradation rate in soil, degrading in less than two months, making them a promising alternative to synthetic non-biodegradable packaging film.

Keywords: Chitosan, Starch, PVP, Napier Grass, Composite, Biodegradable, Packaging

DOUBLE-NETWORK COMPOSITE HYDROGEL FOR SUSTAINED DRUG DELIVERY APPLICATIONS

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A drug delivery system (DDS) presents an excellent platform for the delivery of therapeutics into the body. In the recent past, many clinical disorders such as cardiovascular diseases, diabetes, and cancer have been treated through advancement in pharmaceutical science. Along with the potential of DDS, it requires cytocompatibility, on-demand accurate amount of drug release, and high loading efficiency for the system to be highly efficient. Among many types of drug carriers, hydrogels have captured considerable attention. Hydrogel, a three dimensional (3D) polymeric network, is mainly comprised of hydrophilic moieties responsible for retaining a large amount of water or biological fluid while sustaining its structure. Therefore, naturally occurring polymers are used for designing hydrogels. The degree of crosslinking, ionization, and hydrophilic/hydrophobic properties of the hydrogel are considered significant parameters that are intended to control the equilibrium, swelling, phase transition, and release profiles of therapeutic moieties. However, besides the well-established biodegradability and biocompatibility of natural polymeric-based hydrogels, their mechanical properties limit their potential for true clinical applications. In this study, favorable properties of collagen-based material, gelatin, are combined with the mechanical properties of a nonwoven web. This nonwoven web is made up of recycled polyester (polyethylene terephthalate (PET)). For this purpose, needle-punched nonwovens of PET were prepared with three different areal densities (50, 85, and 110 gm/m2). On the other hand, photo-cross-linkable gelatin was prepared by reacting gelatin with methacrylic anhydride. Doxorubicin was used as a model drug and loaded in methacrylated-gelatin (GelMA) solution. The nonwoven fabrics were soaked in drug containing GelMA solutions followed by photo-crosslinking under visible light (514 nm). FTIR and SEM analyses of the samples indicate the successful and uniform incorporation of GelMA throughout the nonwoven matrix. Drug release studies indicate that composite hydrogel can serve as a sustained drug release system. CellTiter-Glo assay reveals that cells couldn't grow and survive onto nonwoven samples alone; however, viability was enhanced significantly after the incorporation of GelMA. Conclusively, a double network hydrogel system of PET and gelatin can be considered an efficient system that combines the biomechanical properties of gelatin and PET and presents a sustained drug release system.

Keywords: Nonwoven, gelatin, composite hydrogel, cytotoxicity, drug delivery

A STUDY OF THE DOUBLE-LAP ADHESIVE JOINTS BETWEEN METAL AND COMPOSITE'S FATIGUE BEHAVIOR

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In this study, double lap adhesive joints were constructed, and their mechanical properties were assessed. The joints were built of metal (AA 6061-T6) and composite (Kevlar/epoxy laminates). Prior to the fabrication of joints using hand layup technique, surface treatments are applied to metal sheet, such as grinding with sandpaper, degreasing, and anodizing (with phosphoric acid). The same approach was used to produce two different joint configurations. The double epoxy lap joint is employed in the first instance, whereas the double phenolic lap joint is used in the second. The strength of these joints under fatigue loadings was compared. To evaluate the fatigue life under tension-tension fluctuation sinusoidal stress, experimental investigation was conducted. The results showed that the fatigue life of the double epoxy lap joint was better than that of the double phenolic lap joint. Inhomogeneity (air bubble) in the adhesive was shown to be detrimental during fatigue testing, however the length of time between two consecutive cycles spans had a favorable impact on the longevity of joints.

Keywords: Double lap, fatigue, Metal and Composites, fatigue life

CONDUCTIVE POLYMERS AS A VERSATILE MATERIAL FOR BIO APPLICATIONS

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Conductive polymers are gaining significance due to their exception physical, mechanical and electrical attributes for the development of smart textiles. There's a massive range of applications for it in the biomedicine field. In this paper, the versatility and uniqueness of these materials have been discussed for wide range of biomedical applications. These materials are electrically conductive and having mechanical flexibility, but they all share biocompatibility, making them useful in medical practices. The application conductive polymers include bioelectrodes, biosensors, neural interfaces, drug delivery systems, and tissue engineering among others. The benefit to using this is their ability to be stable and create a good interface between electronic devices and biological tissues. This paper will go over the challenges and recent advancements in using conductive polymers for medical applications. It talks about things like long-term stability, scalability, and biocompatibility. In addition to those topics, it also touches on how crucial it is to select the right type of conductive polymer materials and strategies to enhance their overall performance of smart textiles. To close things off, this paper discusses how much potential conductive polymers have in being used for challenges in the medical field. In a way they're flexible and strong like platinum. They can adapt and be used in many ways to improve healthcare for patients. As we continue to work with them it's expected that conductive polymers will play a significant role in shaping the future of medical devices and therapies for years to come.

Keywords: Conductive polymers, Biomedical applications, Smart textile, E-Textile

INVESTIGATING PABA-MODIFIED CELLULOSE NANOFIBERS FOR SUPERIOR BIOPLASTIC ATTRIBUTES

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In this study, we investigate the potential of cellulose nanofibers (CNFs) in combination with wheat proteins as eco-friendly alternatives to synthetic materials for various applications. The CNFs were obtained from two different sources, namely sugarcane bagasse and Eucalyptus bark, using distinct mechano-chemical treatments. CNFs were successfully esterified with para-amino benzoic acid (PABA) to enhance their compatibility with wheat gluten (WG) for biocomposites manufacturing. The modification significantly improved CNF dispersibility, solubility in organic solvents, surface properties, mechanical properties, and thermal stability. Results from Zeta-Analysis confirmed nanoscale fiber sizes (100-200 nm) and decreased polydispersity index (PDI), indicating enhanced dispersibility. FTIR analysis validated the successful isolation and esterification of CNFs, with distinctive peaks at 1040 cm-1, 1367 cm-1, 3340 cm-1, and a new peak at 1738 cm-1. UV-visible spectrophotometry verified PABA attachment to CNFs with peaks at 288 nm. Comprehensive characterization of CNF-incorporated WG films, including tensile testing, FTIR analysis, and antimicrobial assays, highlights the potential for improved mechanical properties and sustainable bioplastic applications. This research underscores the sustainable and environmentally friendly prospects of CNFs in enhancing bioplastic performance.

Keywords: Cellulose Nanofibers, para-amino benzoic acid (PABA), Bio composites, Gluten films

DEVELOPMENT OF THERMALLY STABLE SEMI-CRYSTALLINE ADVANCED COPOLYESTERS FOR HIGH TEMPERATURE COMMERCIAL APPLICATIONS

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In this work, the thermal properties of conventional poly (1,4-cyclohexylenedimethylene terephthalate (PCT) copolyesters was controlled by addition of 2nd diol, BPA. A series of PCT_BX was synthesized containing the various concentration of BPA (0-100 mole%) were synthesized by a simple one-step solution polymerization method at room temperature without the use of stabilizer and metallic catalyst. The actual composition of the copolymer was determined by 1H-NMR. Thermal properties of synthesized copolyesters were determined by differential scanning calorimetry (DSC) and thermogravimetric analysis (TGA). Thermal properties of synthesized PCT_BX were controlled by varying the ratio of BPA in diol part. Main thermal degradation temperature increased with increasing BPA content and degradation proceeded in two steps. DSC results confirmed that as the BPA content increases, the glass transition temperature and the melting point increase linearly. However, in the region where the BPA content is 25 to 55 %, no melting occurred, which can be due to the destruction of the regularity of the polymer chain and the disappearance of the crystalline region. Synthesized copolyesters with high thermal properties can be suitable for versatile high temperature applications.

Keywords: BPA, 1,4-cyclohexanedimethanol, terephthalic acid, solution polymerization, copolyesters, thermal properties.

ECO-FRIENDLY BIOPLASTICS: TRANSFORMING WASTE INTO SUSTAINABLE SOLUTIONS

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Environmental problems caused by petroleum-based plastics have been increasing at an alarming rate. Petrochemical based plastics have been widely used as packaging materials, as they have good barrier properties, stiffness, tensile and tear strength. The accumulation of plastic waste has become a major concern in the environment. Conventional plastics not only take many decades during decomposition, but also produce toxins while degrading. Keeping in mind about the pollution and harm caused to the nature, there is a need to produce plastics from materials that can be readily eliminated from our biosphere in an “eco-friendly” fashion. It is possible to produce such different plastic objects with reduced costs, being more accessible to the population. Conventional plastics can be replaced by bioplastics, Bioplastics are considered as environmental friendly materials alternatives to plastics and they are produced from renewable biological resources such as corn, maize, cassava, sugarcane, wheat, rice, potatoes and their peels, banana peels etc. which, when disposed of under-favourable conditions, decomposes faster. These plastics are environment friendly & biodegradable, and are safer option than the petroleum-based plastics. Keeping this in mind, potato waste based starch was explored for their suitability to prepare bioplastic films with selected crosslinkers and non-toxic additives. Besides this, a large amount of protein is destroyed during starch extraction due to acid treatment. CRISPR/Cas9 technology was employed to increase the degradation temperature of potato proteins (patatins) so they could be used for food purposes.

Keywords: Starch, Bioplastics, Food waste, CRISPR/Cas9

INVESTIGATING THE ACTUATION PROPERTIES IN RECYCLED FIBER-REINFORCED POLYMER COMPOSITES

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In my research work, thermally active (TA) and electro-active (EA) shape memory polymer composites (SMPCs) were prepared. The recycled polyester fabric with three different areal weights (212.5 g/m^2, 292.7 g/m2, and 332.3g/m2) was used as a reinforcement to get a large bending effect in SMPC, due to its low rigidity. The thermally active SMPCs were fabricated by hand layup method, while unidirectional (UD) carbon tow inserts were used between two layers of polyester fabric for preparing electrically active SMPCs. The shape memory (SM) and shape recovery (SR) capability of all thermally active SMPCS were investigated at different temperatures (50°, 75°, and 100°C). Whereas the electrically active SMPCs were investigated at 50°C. The maximum achieved shape recovery and shape fixity ratios of developed thermally active SMPCs were 100% and 99%, respectively. The electrically active SMPCs also showed 100% shape recovery ratios. The surface morphology of the developed composites was studied using an optical microscope. Craze marks were observed in 3-layered thermally active SMPCs and in the case of electrically active SMPCs craze marks were observed after cyclic loading in those samples prepared with higher areal-weight fabrics. The storage modulus of the samples was measured and showed an increasing trend by increasing the number of layers and areal weight of the fabric in manufacturing thermally active shape memory polymer composites. The maximum storage modulus was observed at 8.2GPa by a sample prepared with three layers of fabric having an areal weight of 332.3 g/m2. Furthermore, the short beam shear strength of the fabricated shape memory polymer composites was also measured and it increased with increasing the fabric areal weight and number of layers, hence the maximum short beam shear strength was observed as 52MPa showed by a sample consisting of three layers having 332.3 g/m2 areal weight.

Keywords: Shape memory Polymer composite, Sustainability, Polyester

DEVELOPMENT OF A TEXTILE BASED MEDICAL PATCH AS TOPICAL DRUG DELIVERY SYSTEM

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The world is moving towards pain-free drug delivery system through skin for treatment of various type of diseases called as transdermal drug delivery devices. Transdermal patch is a medicated adhesive patch which can be applied directly on the skin to provide specific dose of drug through the skin into the bloodstream. Transdermal drug delivery devices can be developed through aqueous or organic solvent casting methods, which restrict the use of insoluble drugs in aqueous media while organic solvents are challenging to remove from the system. The selection of drug and their carrier system are based on their cohesion energies, which defines the physiochemical properties and interaction potential of both drug and carrier system. This study is based on development of a textile substrate in fiber form which can encapsulate drug in its microporous structure and release the entrapped drug at controlled rate when applied on the skin. The medical patch is developed using polyvinyl alcohol co extruded with polycaprolactone fibers through wet spinning process with model drug. The model drug used for the medical patch fabrication was sodium sulfadiazine. The developed fibres were then rinsed and dried. The fibers were analyzed for topographic analysis, Fourier transform infrared spectroscopy, linear density, liquid absorption, swelling behavior, tensile properties, antimicrobial activity, drug release analysis and degradation test. It is concluded that PVA/PCL fibres containing model drug can be developed through wet extrusion process with excellent tensile properties, swelling properties, adequate liquid absorption, degradation percentage, and good antimicrobial activity with controlled drug release profile of the model drug for transdermal drug delivery applications.

Keywords: Transdermal patches, Antimicrobial, drug release, Polyvinyl alcohol, Polycaprolactone

A STUDY ON NOVEL SURFACE TREATMENT PLATING FOR SUSTAINABLE FASHION ACCESSORIES

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While electroplating is noted for its superior decorative appearance, high performance and excellent corrosion resistance, the use of this technology is not without some problems in terms of sustainability. The process involves the use of large amounts of water and electricity, as well as their containment in hazardous areas. There is a need for a new method of sustainable finishing that can save water and reduce the electricity consumption, as well as reducing greenhouse gas emissions. AcroPlating® finishing technology was developed and its effectiveness has been investigated and reported through a Life Cycle Assessment (LCA). According to the tested values, AcroPlating® finishing technology completely eliminates the use of certain harmful substances such as cyanide, chromium and selenium in the plating process. Additionally, the technology reduces greenhouse gas emissions by 96%, water use by 66% and power consumption by 69% during the production process, when compared to conventional plating methods. The developed technology is used in fashion materials such as zipper sliders, snaps and buttons. Fashion is a highly polluting industry and sustainable accessories are crucial for comprehensive sustainability in the textile and fashion industries. A general analysis of the conventional and AcroPlating® finishing technologies using the results of the LCA* are given below:

-Toxic waste products: 100% eliminated

-Thermal energy use: 100% reduction

-Greenhouse gas emissions: 88% reduction (NCOP)

-Water use: 65% reduction (NCOP)

-Sludge formation: 90% reduction (NBLK)

-Electricity consumption: 60% reduction (NCOP)

-Chemical consumption: 67% reduction (NBLK)

* An environmental impact assessment conducted by Peterson Projects & Solutions and verified by Control Union Certifications shows that fewer resources are used as compared to conventional electro-plating and

polishing processes. The stated savings are a maximum value based on comparisons between the conventional processes and AcroPlating® finishing technology.

Keywords: Sustainability, Coating, LCA, Fashion, Textile Accessories

DEVELOPMENT AND CHARACTERIZATION OF SMART POLYMERIC FILM USED FOR FLEXIBLE ELECTRONICS

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To achieve the scheming and fabrication of leading electronic devices (EC), the exclusive analysis of polymeric-film substrates is mandatory. This very research purpose to investigate the synthesis and fabrication of smart film process of PCTN (poly-(1,4-cyclohexylene-dimethylene terephthalate co-1,4-cyclohexylenedimethyl-ene 2,6-naphthalene-dicarboxylate)) polyester. Initially, cold drawing process was applied to attain Biaxial stretching of fabricated film. The same film is the immensely characterized in terms of performance characteristics. For instance, thermal, mechanical, and dimensional stability along with optical, barrier and thermal degradation. The results of XRD, DSC and birefringence demonstrated that with an increased biaxial stretching, the biaxal stretching of smart film increases the regular arrangements of molecular chains that eventually improves its examined performance characteristics. The biaxially stretched (BS) smart film PCTN have high glass transition temperature (Tg i.e.124.30°C), wide-processing range Tm i.e. 276.80°C), batter transmittance that is 94%, -4, low water-absorption i.e. 0.16%, low-birefringence i.e. 3.71×10, batter thermal degradation-behavior (Tid-5%, 413.1°C), and dimensional-stability coefficient of thermal expansion (13.6 ppm°C-1, -55 to 85°C) as compared to the conventional polymeric-substrates (PI, PET, and PEN) for advanced EC. The novel performance attributes of this established BS-PCTN film makes it a very potential candidate as a polymeric substrate. Within the flexible EC, this BS-PCTN, as a polymeric-substrate, holds really promising future avenues.

Keywords: Co-polyesters, Biaxial stretching, Structure-property relationship, Smart polymeric film, flexible devices, performance characteristics

NANOCELLULOSE-BASED COMPOSITES FOR FLEXIBLE FUNCTIONAL ENERGY STORAGE DEVICES: CHALLENGES AND FUTURE PERSPECTIVE

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The growing need for advanced energy storage solutions has sparked interest in the utilization of nanocellulose as a sustainable and high-performance nanomaterial. This comprehensive review encompasses various aspects of nanocellulose's role in electrochemical energy storage, offering a thorough exploration of its unique properties and applications. The review begins with an introduction to the structural features of cellulose nanofibers within cellulose resources and delves into the processes employed to create nanocellulose with diverse structures and surface properties. The focus then shifts to the application of nanocellulose in energy storage systems, encompassing supercapacitors, lithium-ion batteries, lithium–sulfur batteries, and sodium-ion batteries. This section underscores the integration of nanocellulose with other active materials, the development of flexible substrates, and the pyrolysis of nanocellulose to produce carbon materials with functionalization possibilities. The review identifies key areas for future research and development in this vibrant field, stressing the importance of sustainable and environmentally friendly solutions for advancing energy storage technology, ultimately contributing to the realization of the "Battery-of-Things (BoT)" era. This collective insight into nanocellulose's potential in addressing the challenges of energy development and environmental concerns promises to inspire further exploration and innovation in the field.

Keywords: Nanocellulose, Nano-structures, Electrical properties, Energy storage field; Flexible Functional Energy Storage

NANOCELLULOSE AS REINFORCEMENT IN PAPER PROCESSING AND PAPER PRODUCTS: CHALLENGES AND FUTURE PERSPECTIVE

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In the context of addressing the demands for higher-quality paper products while considering environmental sustainability, this comprehensive review explores the utilization of nanocellulose (NC) and nanocellulose-based bio-additives in the papermaking industry. The study investigates various aspects of incorporating these "green" nanoadditives, particularly in terms of enhancement, retention, filtration, and coating aids, to achieve more efficient production and functionalization of paper. It highlights that NC is being formulated with other polymers and particles to leverage their synergistic effects, emphasizing the pursuit of commercially viable developments. Furthermore, it underscores the increasing interest in specialty papers and the efficient utilization of recycled fibers, offering valuable insights for industry advancements. Additionally, a comparative analysis is presented regarding the impact of mechanical and chemical treatments on the production of NC, particularly for reinforcing recycled paper products. The study shows that improved mechanical properties, drainage, and flocculation can be achieved when Old Corrugated Container (OCC) pulp is reinforced with NC. This research contributes to the ongoing efforts to maximize the benefits of NC as strength-enhancing additives in papermaking, reducing material costs, and enhancing overall paper quality.

Keywords: Nanocellulose, paper additive, mechanical, barrier, paper and paper-based product, specialty paper, recycle, functionalization

INNOVATIVE MAGNETIC CELLULOSE MATERIALS FOR ENVIRONMENTAL AND INDUSTRIAL APPLICATIONS: A COMPREHENSIVE REVIEW

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Efficient adsorption materials for addressing environmental challenges, such as oil spills and water pollution, have led to innovative solutions involving cellulose-based materials with hydrophobic and magnetic properties. For instance, magnetic nanocellulose (NC) aerogels have been developed for efficient oil and organic solvent adsorption. Another approach involves converting olive industry solid waste into magnetic NC materials, efficiently extracting methylene blue from water. Further developments include the synthesis of magnetic NC with superparamagnetic properties and the creation of low-density, highly porous, hydrophobic spherical NC-derived aerobeads for efficient oil and chemical spill cleanup. Combining nanocellulose and magnetic nanoparticles shows potential for diverse applications, including friction layers for triboelectric nanogenerators, energy production, and wearable electronics. Additionally, the incorporation of magnetic particles in the polymer matrix enhances the decontamination of metal ions in wastewater, with applications such as removing organic dyes. These innovative developments in NC-based materials demonstrate their potential for a wide range of environmental applications, offering sustainable and environmentally friendly solutions for various challenges.

Keywords: Magnetic nanocellulose, nano-structures, wastewater treatment, oil spill, dye, adsorption, modification

PROGRESS IN POLYMER COMPOSITES AND THEIR BLENDS ENCAPSULATION ADVANCED TECHNOLOGY FOR CONTROLLED-RELEASE FERTILIZERS

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The ongoing challenge in fertilizer manufacturing is to enhance the effectiveness of nitrogenous fertilizers while reducing ecological impact. Controlled-release fertilizers (CRFs) provide a solution, with various materials and techniques used to maintain nutrient release. Biodegradable polymer-coated CRFs offer cost-efficiency and environmental benefits, but challenges in biodegradation assessment persist. Efficient use of fertilizers, especially nitrogen, can be achieved through urea nanocomposites, which reduce N2O emissions. The global demand for food drives high chemical fertilizer consumption, emphasizing the need for sustainable practices. Starch-based CRFs offer a renewable and biodegradable solution, with modifications to enhance nutrient release and soil moisture retention. Controlled-release fertilizers play a crucial role in sustainable agriculture, offering precise nutrient release and reducing environmental impact. Bio-nanocomposites hold potential as coating materials, bridging the gap between CRFs mechanisms and nanotechnology application for enhanced crop sustainability. The future perspective lies in the continued development of CRFs and bio-nanocomposites for sustainable agriculture.

Keywords: Bio-nanocomposite, Biodegradable polymer, Controlled release fertilizer, Nutrient release, Starch

DEVELOPMENT OF CHITOSAN AND CURCUMIN BASED AQUEOUS POLYURETHANE DISPERSIONS FOR TEXTILE FINISHES TO IMPROVE THE PHYSICOCHEMICAL CHARACTERISTICS OF TEXTILE SURFACES

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The present research work aims to synthesize a blend of chitosan (CSN) and curcumin (CRN) based aqueous polyurethane dispersions (CSN-CRN APUDs) for the modification of textile surfaces. A series of anionic CSN-CRN APUDs was synthesized by reacting isophorone diisocyanate (IPDI) with polyethylene glycol (PEG) and incorporating chain extenders (CSN and CRN). Structural characterizations were conducted using Fourier-transformed infrared (FTIR) spectroscopy. The performance of CSN-CRN APUD-coated textiles was evaluated in terms of colorfastness (washing, rubbing, and perspiration) and mechanical properties such as tensile and tearing strength. The study included various poly/cellulosic textiles, including dyed, printed, and white samples. The results demonstrated a significant enhancement in both the mechanical and colorfastness properties of the poly/cellulosic textiles treated with CSN-CRN APUDs in comparison to untreated textiles. Importantly, the CSN-CRN APUD coating materials are sustainable and eco-friendly, derived from bio-resources. These materials represent promising eco-friendly alternatives for modifying poly/cellulosic textile surfaces.

Keywords: Chitosan; curcumin; anionic aqueous polyurethane dispersions; poly/cellulosic textiles

SYNTHESIS AND APPLICATION OF GRAPHENE OXIDE FROM WASTE CELLULOSIC FIBERS FOR WATER REMEDIATION

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Graphene oxide, a two-dimensional material has gained significant attention due to its outstanding properties and it has potential applications for the adsorption of dyes. Graphene oxide was synthesized from waste cotton fabric by hydrothermal method. To evaluate the adsorption capacity of the synthesized graphene oxide, it was used as an adsorbent for dye removal. The results showed that the synthesized graphene oxide has effective interactions with dye molecules and all molecules of dye were adsorbed. Thus, graphene oxide has proved as an effective adsorbent for dye removal and could be used for various applications.

Keywords: Graphene oxide, dyes, cotton fabric

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Keywords: Bio-nanocomposite, Biodegradable polymer, Controlled release fertilizer, Nutrient release, Starch

FABRICATION OF GLASS FABRIC AND NANO FILLER REINFORCED COMPOSITES STRUCTURE FOR DEFENSE APPLICATIONS

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