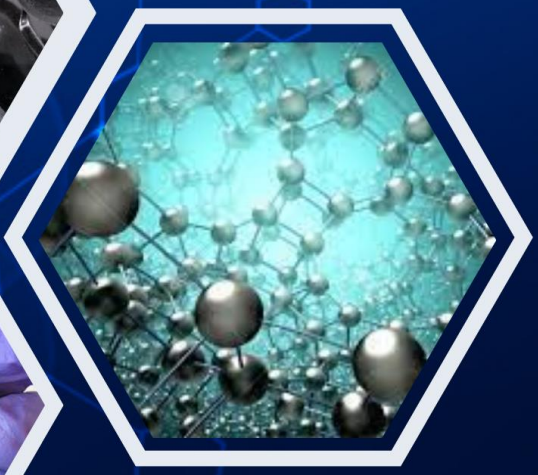
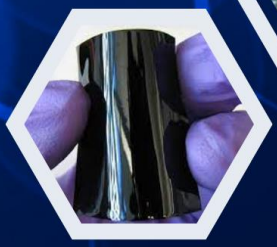
ICPC

6-7 December, 2022





Conference Proceedings

International Conference on **Polymers and Composites**

6-7 December, 2022

(Hybrid Conference)

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MESSAGE FROM THE CHAIRMAN OF CONFERENCE

It is my pleasure to welcome all the participants to the 2nd International Conference on Polymers and Composites, organized by the Department of Materials, National Textile University, Faisalabad. I would like to thank the collaborators of this conference, University Teknologi Malaysia, National Centre for Composite Materials (NCCM), School of Materials Science and Engineering, Northwestern Polytechnical University, Xian, China.

I would like to thank the distinguished speakers and poster presenters who participated in this conference to make the event successful. I hope this event will surely help the participants 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 this event. The theme of this conference is "polymers and composites". "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.

This conference is also the 2nd step towards 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. Gilles Lubineau

King Abdullah University of Science and Technology, KSA

Prof. Wesley Cantwell

Khalifa University, UAE

Prof. SM Sapuan

University Putra Malaysia

Prof. Fouad Erchiqui

University of Quebec, Canada

Prof. Azman Hassan

University Teknologi Malaysia

Prof. Bruno Castanie

University of Toulouse, France

KEYNOTE TALKS

High-performance Sandwich Structures for Energy-absorbing Applications

Wesley J. Cantwell, Khalifa University of Science and Technology, Abu Dhabi, United Arab Emirates

Mechanical performance of sugar palm fibre ash reinforced LM 26 aluminium matrix composites

Mohd Sapuan Salit and Aliyu Isah, Department of Mechanical and Manufacturing Engineering Universiti Putra Malaysia

Microwave potential for thermoforming of bio-composites

Fouad Erchiqui, Laboratories of Bioplasturgy and Biomaterials, Engineering school, University of Quebec in Abitibi-Témiscamingue, Rouyn-Noranda, Québec, Canada

Composite sandwich structure in aeronautic applications

Prof. Bruno Castanié, University of Toulouse, France

Poly (lactic acid): A Versatile Bio-based Polymer for the Future

Prof. Dr Azman Hassan, Universiti Teknologi Malaysia

Introducing crack-arrest features in boltfree bonding by substrate and/or adhesive texturing

King Abdullah University of Science and Technology, KSA

HIGH-PERFORMANCE SANDWICH STRUCTURES FOR ENERGY-ABSORBING APPLICATIONS

Wesley J. Cantwell

Khalifa University of Science and Technology Abu Dhabi, United Arab Emirates

Lightweight sandwich structures are finding widespread use in a range of engineering applications, including those associated with the aerospace and defense sectors. In many cases such components are subjected to extreme forms of dynamic loading and their response to such conditions needs to be understood and, if possible, enhanced. This presentation will discuss recent advances in the development of high-performance sandwich panels for use in impact and blast-resistant structures. A review of the energy-absorbing performance of traditional sandwich structures will initially be given followed by a summary of more recent developments that aim to double the absorption response of current systems. Here, the use of novel all-composite honeycombs, tube-reinforced foams, strut-reinforced Nomex honeycombs as well as additively-manufactured lattice designs is considered. Attention is given to understanding the strain-rate sensitivity of these systems and understanding how energy is absorbed under dynamic loading conditions.

Keywords: Nomex, aerospace, honeycombs

MECHANICAL PERFORMANCE OF SUGAR PALM FIBRE ASH REINFORCED LM 26 ALUMINIUM MATRIX COMPOSITES

Mohd Sapuan Salit and Aliyu Isah

Department of Mechanical and Manufacturing Engineering Universiti Putra Malaysia

Natural fibres, in various forms, are abundant in large quantities all over the world, but if not properly harnessed, can led to environmental pollution. Natural fibre ash contains hard ceramic components, when combined with aluminium metal matrix (AMM), improve its mechanical properties via microstructural refinement. Aluminium matrix composites (AMCs) have numerous applications in the automotive, aerospace, medical, and construction industries. The goal of this research is to assess the mechanical performance and physical properties of LM 26 Al-matrix composites reinforced with sugar palm fibre ash particles. The composites were produced using a low-cost production method known as stir casting, which involved varying the content of sugar palm fibre ash (SPFA) in LM 26 Al-matrix from 0 to 10 wt% at 2 wt% intervals. The mechanical, and physical properties of the fabricated composites (hardness, tensile strength, compression strength, density, and percentage porosity,) were assessed and compared to that of the matrix. The addition of SPFA reduced the density of the fabricated composites while slightly increasing porosity. The hardness, tensile and compression strength were found to be improve with the addition of sugar palm fibre ash. The highest hardness, tensile and compression strength were achieved with the composite containing 8 wt% SPFA. The density of the composite with 10 wt% SPFA addition was found to decrease by 5.2 %. The hardness, tensile and compression strength was found to have increased by 43.12 %, 24.67 %, and 20.06 % respectively at 8 wt% SPFA addition. These findings revealed improvement in the mechanical and physical properties of LM 26 aluminium metal matrix which could use in automotive industry for the production of piston and other car components.

Keywords: Aluminium matrix, sugar palm fibre, stir casting, physical properties, mechanical characteristics

MICROWAVE POTENTIAL FOR THERMOFORMING OF BIO-COMPOSITES

Fouad Erchiqui

Laboratories of Bioplasturgy and Biomaterials Engineering school, University of Quebec in Abitibi-Témiscamingue, Rouyn-Noranda, Québec, Canada

Composites based on vegetable reinforcements and thermoplastics are considered as alternative materials in several industrial sectors such as automotive, aviation, textile, leisure and construction. These natural reinforcements have several qualities compared to mineral reinforcements: low density, low cost and less abrasive. However, the thermoformability of these materials for thermoforming applications does not yet seem to be sufficiently elucidated in the literature. For this process, heating by infrared radiation, which is the most used technique, represents up to 80% of the energy consumption, which is an important economic cost. In addition, this heating method induces non-uniform temperature distributions in the heated sheets (the outer surface of the sheets is hotter than the center), which affects the quality of the thermoformed products. To circumvent this problem and make the thermoforming process efficient in time and heating quality, the conference suggests, for a judicious choice of the size of the bio-sourced reinforcements, microwave heating, which may lead to a new niche in research on high-performance bio-composites for thermoforming. This is due to the presence of water molecules, in the form of bound molecules, in the plant reinforcements. Indeed, these water molecules interacting with microwaves dissipate part of their energy as heat in the composite. The amount of energy dissipated depends on several parameters such as: the concentration of plant reinforcements, the morphology of the fibers, the moisture present in the reinforcements, the matrix, the temperature and the frequency and intensity of the microwaves. To illustrate this, a numerical comparison is performed between infrared and microwave heating modes on a family of polypropylene (PP) sheets loaded or not with wood reinforcements of different sizes. The results show that the temperature distribution in the sheets is almost uniform using microwave and the heating time can exceed that of infrared.

Keywords: Thermoforming, Thermoplastic, Reinforcement

COMPOSITE SANDWICH STRUCTURE IN AERONAUTIC APPLICATIONS

Prof. Bruno Castanié

University of Toulouse, France

A sandwich structure consists of the skin of of high-strength outer layers, separated by an inner layer called the core. An adhesive layer is used to join the skin layers with the inner core. A large number of material combinations for skin and core are being used today, depending on the application area. However, the possibilities are quite limited when sandwich structures are used for aeronautical applications. The most common materials and architectures used for these applications include honeycomb cores of Nomex, aluminum or some technical foam, and skin of aluminium, carbon, glass or Kevlar fibre composites. These structures are used in aircrafts, helicopters, satellites and space structures owing to their better mechanical performance, light weight and damage resistance.

Keywords: Kevlar fibre, sandwich structure, aluminium, carbon

INVITED TALKS

DESIGN FOR ADDITIVE MANUFACTURING OF CELLULAR LATTICE STRUCTURES

Aamer Nazir

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The cellular lattice structures are a network of interconnected unit cells, offering advantages like minimal material consumption, high strength-to-weight ratio, enhanced energy absorption, etc. Owing to these advantages, these structures are preferred for engineering systems, reducing their weight and enhancing mechanical performance. These cellular lattice structures can be produced by conventional as well as advanced manufacturing techniques like additive manufacturing (AM). The AM technology offers unique advantages of customized manufacturing in terms of geometry, shapes, inner size, etc. This talk will include the state-of-the-art on designing of cellular structures using AM technology for researchers in academia and industry.

Keywords: Additive manufacturing, cellular structures, cellular lattice structures

SUSTAINABLE HIGH PERFORMANCE GREEN COMPOSITE FOR EMERGING APPLICATIONS

Tahir Sharif

Derby University, UK

UK is the first major economy to pioneer a "green industrial revolution" by passing legislative laws backed with funding; this is driving the composite industry to work towards sustainable development. Traditionally most composite are derived from oil, however, to meet UK strategic economy target of net zero by 2050, bio-based or recycled alternatives are promising solutions to minimizing environmental impact. This has fueled research and development of natural fibre and matrix development. University of Derby (UoD) Composite Research group is playing a vital role to overcome these challenges. In the conference following topics will be covered:

- Role of sustainable composites in emerging applications
- Formulation of Bio-based polyfurfuryl alcohol resin suitable for snap curing and autoclave application.
- Optimization of bio-based polyfurfuryl alcohol prepreg for composite material applications
- Use of recycled composite for sandwich composite applications.

Keywords: Polyfurfuryl, sandwich composite, recycled

FUTURE OF COMPOSITE MANUFACTURING WITH AUTOMATED FIBER PLACEMENT: CHALLENGES AND OPPORTUNITIES

Hatice Sinem Sas

[1]Integrated Manufacturing Technologies Research and Application Center, Sabanci University, Istanbul, Turkey

[2]Composite Technologies Center of Excellence, Sabanci University-Kordsa, Istanbul, Turkey

With the advent of newer technologies for composite fabrication and their application in high-tech areas, the need has arisen to control the fiber architecture to control its mechanical performance. Automated Fiber Placement is the approach developed for this purpose. In this approach, the fibers are laid along a specific path as required in the end product using a robotic arm. However, this approach is at infancy stage and its use is very limited. This talk will discuss the future of the Automated Fiber Placement technique for composite fabrication, highlighting the opportunities and challenges.

Keywords: Composite, robotic arm, Automated Fiber Placement

APPLICATION OF COMPOSITES IN BIOMEDICAL APPLICATIONS

Hassan Mehboob

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Biocompatible composites have excellent mechanical properties compared to the conventional metals. They possess higher fatigue life, lightweight, non-corrosive behavior, low stiffness and reduce harmful ions. Such composites are widely used nowadays to biomedical field especially for the design of implants. Material properties of composite implants can be easily tailored to mimic the bone properties. These composite implants address the complications produced by the dense metallic implants such as stress shielding, bone resorption and non-unions. Moreover, biodegradable composites are getting attention due to their biodegradation, bioactivity, drug release and improve the healing rates. The stiffness and strength of these biodegradable composites are still challenging for the long bone fractures.

Keywords: Composite, Biocompatible, stress shielding, bone resorption

SEMICONDUCTING POLYMERS FOR ORGANIC ELECTRONICS

Raja Shahid Ashraf

Department of Chemistry, Government College University, Lahore, Pakistan

Organic electronics deals with the organic polymers exhibiting electronic properties such as electrical conductivity. These materials are being intensely explored for both technical as well as biomedical applications. In this study different semiconducting polymers used for organic electronics will be introduced, along with their synthesis, properties, and application areas.

Keywords: Organic, electronics, semiconducting

STRENGTHENING OF BRICK MASONRY STRUCTURE WITH FRP

Samiullah Qazi[1], Khyber[2], Imad Ahmed[2], Khan Shehzada[3]

1: Assistant Professor, 2: Research Students, 3: Professor, Civil Engineering Department, University of Engineering and Technology Peshawar, KPK

This research work objective is to evaluate the seismic performance of brick masonry structures strengthened with Fiber Reinforced Polymers (FRP). Brick masonry structures are commonly used in developing countries because of their simplicity, aesthetics, heat insulation, and economy. However, these structures are vulnerable to earthquakes due to their weak lateral load resistance. The effect of confining brick masonry through reinforced concrete members has been evaluated in the past but it's a lengthy process as it requires partial destruction and repair. Therefore, in this research work, the FRP bonding technique is used to strengthen the brick masonry room constructed at a 1:3 scale. The room structure is a typical rural structure constructed in the subcontinent. The aims are to evaluate the influence of external FRP strengthening techniques.

Keywords: Brick Masonry, FRP, Strengthening, Confinement

LIGNOCELLULOSIC FIBERS REINFORCED THERMOPLASTIC STARCH (TPS) BIOCOMPOSITE

R.A. Ilyas

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Thermoplastic materials derived from starch are one of the most potential substitutes for developing bio-based materials because of their widespread availability and renewable nature. Over the last few years, the addition of natural fibers in biocomposite films as filler materials has been found to lower costs while improving overall performances. There are numerous natural fibers that could be used to reinforce films, including sugar palm, black seed, sugar cane, cassava, corn, and wheat straw. Natural fiber has been used in wide range of applications from flexible packaging to advanced bio-scaffolds for tissue regeneration. It is due to its outstanding properties such as excellent mechanical properties, high thermal resistance, good optical properties, high aspect ratio with anisotropic shape, good biocompatibility, high crystallinity, large specific surface area, abundant surface hydroxyl groups for modification, and tailorable surface chemistry. Currently, natural fiber is widely used to reinforce thermoplastic starch (TPS) to improve the mechanical and water barrier properties of TPS. In this presentation, we explain the outline of current development in this particular field, including the modification, characterization, behavior, and various applications of natural fiber reinforced TPS biocomposites. Besides that, we hope to impart the audience with some of the excitement that currently surrounds TPS biocomposites research, which ascends from the renewable source nature of the particles, their fascinating, morphological, mechanical, chemical and physical properties, and the variety of applications that can be developed from these biocomposites.

Keywords: lignocellulosic fibers; nanocellulose; thermoplastic starch; polymer biocomposite; biodegradable

ORAL PRESENTATIONS

A STUDY ON HEMP SEED OIL/POLYCAPROLACTONE BASED WOUND DRESSING STRUCTURES BY MAKING USE OF ADDITIVE MANUFACTURING METHODS

Ihsan Fatih Ertas[1], Md Humayun Kabir[1], Muhammet Uzun [2,3], Eray Altan[2], Oguzhan Gunduz[2,4]

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[4]Department of Metallurgy and Materials Engineering, Faculty of Technology, Marmara University, Istanbul, Turkey

Hemp plant is already quite familiar for its spectacular medical benefits and usage. Hemp oil which is extracted from hemp seeds of the Cannabis Sativa plant is mainly composed of monoterpenes and sesquiterpenes. It also has Omega-6 and Omega-3 fatty acids, gamma-linolenic acid, and other nutritional antioxidants. It has unique characteristics which enables its usage in pharmaceuticals, cosmetics, and other fields. Moreover, it has the ability to help with various health issues such as inflammation. Additive manufacturing which is 3D printing is used to fabricate three-dimensional structures with the help of computer aided design (CAD) through a method of layering. Earlier it was only used for quick creation of product models and prototypes but nowadays final products are also produced by 3D printers. In this study, 3D printing technique was used to produce scaffold structures loaded with different combination of hemp seed oils. Scaffolds are generally developed and used for the regeneration of new functional tissues. Morphological analyzes of scaffold structures were completed using Scanning Electron Microscopy (SEM), Fourier transform infrared spectroscopy (FTIR) and Differential Scanning Calorimetry (DSC). The SEM results showed the differences in the morphology of the scaffold structures of pure hemp seed oil and commercially available hemp seed oil. It was concluded from the mechanical properties of both scaffolds that the scaffold produced from pure hemp seed oil possesses two times higher elongation in comparison to the scaffold produced from commercially available hemp seed oil. Experimental results also exhibited that pure hemp seed oil possesses better antibacterial activity. It is also important to mention that purification of seed oil's CBD content is the main negative effect on antibacterial activity. The processability of hemp oil is the main aim of this research and it is successfully processed with different combinations.

Keywords: Hemp Seed Oil, Meditech, 3D Printing, Wound Dressing

DEVELOPMENT OF ECONOMICAL NANOCOMPOSITES THROUGH UPCYCLING OF PERSONNEL PROTECTIVE EQUIPMENT (PPE) WASTE FOR AUTOMOTIVE AND ELECTRONICS APPLICATIONS.

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Owing to the massive utilization of non-woven materials and due to the increasing use of non-woven fabric products as personal protective equipment (PPEs), their recycling/upcycling and conversion to high-performance products is the biggest challenge. Reusing the waste polymers revealed that their qualities were insufficient, notably in terms of their thermal, mechanical, and rheological behavior. This research aims to develop a nanocomposite by upcycling personnel protective equipment waste suitable for electronic and automotive applications. The PP/CB nanocomposite was prepared using the melt blending technique. Initially, nonwoven polypropylene salvage of PPEs from industrial waste facilities was collected. The collected material was compressed by utilizing vertical compression molding technology to prepare thick sheets. In the next stage, compression-molded sheets of nonwoven PP fabric were crushed by utilizing a high-speed rotating blade small industrial shredder. The resulting shredded material, from the crusher, was ground through a lab-scale milling machine. This powdered PP was mixed with a carbon black nanofiller. After mixing with a nanofiller the economical nanocomposites were prepared in a twin screw extruder and then compressed in a vertical compression-molding machine to form a sample. These compressed samples will be characterized and result in terms of mechanical and electrical properties will be noted.

Keywords: Personnel protective equipment, Upcycling, Nanocomposite, Polypropylene, Carbon black, Melt blending technique, Nonwoven material.

SYNTHESIS AND APPLICATION OF NOVEL POLYURETHANE FILM FOR MATERIAL COATINGS

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Polyurethane (PU) films are regarded as an important polymeric class in coating sectors. PU exhibits various advantageous features like coating, adhesive, sealants, and elastomeric properties. PU structure with careful design is vital in obtaining excellent adhesive and mechanical strength for the final coating product. The present research is designed to develop novel polyurethane films with excellent anti-bacterial and flame retardant properties. Polyurethane films were prepared using isophorone diisocyanate (IPDI) as diisocyanate, 1,4-Butanediol as chain extender, and PTMG-2000 as glycol. The reaction was conducted in a polymerization chamber using DMDEE as a catalyst. Zinc oxide NPs were used as anti-bacterial agents whereas zirconium phosphate (Zr (HPO4)2 was used to attain flame retardancy in the final film. Surface morphology, thermal stability, surface characteristic, and mechanical properties were characterized using FTIR, DSC, contact angle, mechanical testing, and anti-bacterial and flame-retardancy tests to confirm induced functionality in novel PU film.

Keywords: coatings, polyurethane, mechanical strength, glycols, antibacterial

DEVELOPMENT OF SUPERHYDROPHOBIC POLYMER BASED COATING FOR COMMERCIAL SOLAR PANEL

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The incident solar radiation can be directly converted into electrical energy by solar cells. The amount of incoming light incident on solar cells determines the efficiency of the cell. However, a large amount of incident light is lost due to the accumulation of dust on modules or the reflection of light on glass panels. Only 30-40% of the incident solar radiation is used, remaining light is reflected. Thus, to resolve these technological problems, superhydrophobic antireflection coatings are in great demand. The superhydrophobic coating can control wettability due to which it possesses self-cleaning characteristics. The surface possesses unique texture and chemistry because of the low surface energy materials with nano/micro texturing of materials enhancing anti wetting properties. These surfaces possessed superhydrophobic properties by showing contact angle of water with a surface greater than 150o due to which water droplets roll off from the surface. Similarly, the transparent coating can reduce the reflection of light from the surface due to optical path differences. High transparency is highly desirable in these transparent superhydrophobic coatings applied on optical and transparent equipment such as windows, solar panels, lenses, membranes, etc. In this project, we will develop superhydrophobic anti-reflective coating by combining fluoropolymer with metal oxide i.e. TiO2. The reason for using fluoropolymer is its low surface energies that are the main requirement of producing superhydrophobic coating. Similarly, TiO2 is used owing to its lower refractive index value of 2.1-2.6 in comparison to other energy means; it could be used as antireflection coating for the fabrication of electrical energy conversion devices.

Keywords: Superhydrophobic, Titinium dioxide (TiO2), antireflection coating

DIGITAL INK-JET PRINTING OF REGENERATED CELLULOSE ELECTROSPUN NANOFIBROUS MATS WITH REACTIVE INKS

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Nanofibres' versatility allows them to be used for various technological applications, such as filtration, medical, composites, protective and functional textiles. Recently, in addition to the functional properties of electrospun nanofibrous mats their aesthetic properties have been explored. Herein, attempts have been taken to develop digital inkjet printing of regenerated cellulose electrospun nanofibrous mats with reactive inks for the first time. Firstly, cellulose acetate polymer solution was made to fabricate electrospun cellulose acetate nanofibrous mats then converted into regenerated cellulose electrospun nanofibrous mats through deacetylation. After that cellulose electrospun nanofibrous mats were treated with alkaline solution, then the mats were colored with four commercially available reactive inks (cyan, magenta, yellow and black) by digital inkjet printing method using piezo-electric digital inkjet printer. Various parameters such as optimal concentration of pretreatment agents, fixation temperature and time, color yield and absorbency of electrospun nanofibrous mats were explored. The digital inkjet printed electrospun cellulose nanofibrous mats had excellent color yield (K/S value) and colorfastness to washing and light.

Keywords: Cellulose acetate polymer, regenerated cellulose electrospun nanofibrous mats, deacetylation, and digital inkjet printing, reactive inks, color yield.

COTTON CROSSLINKED ZNO/MGO BIO IMMOBILIZED MATRIX FOR EFFECTIVE PHOTODEGRADATION AND SELF-CLEANING PERFORMANCE

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University of Engineering and Technology Lahore (Faisalabad Campus)

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Cleaning of clothing especially the upholstery and automotive textile always have been a hectic and time-consuming job along with utilization of huge amount of water and energy. According to the report, the domestic cloth washing consume around 20 billion cubic meters of fresh water per annual globally along with contamination of the underground water with detergent ingredients. Transition metal oxides (TMOs) are well known for their photocatalytic performance yet use of TMOs in wastewater act as an added impurity due to ineffective remove from water after degradation. Herein we successfully introduced immobilized nano-photocatalyst for multifunction self-cleaning textile and photo degradation of wastewater. The chitosan a natural biopolymer was used as immobilizing matrix for ZnO/MgO. The bilateral interaction of bio-coagulant with TMOs and textile was established with FTIR. The as-prepared composite presents an effective degradation of color (up to 89 %) both against commercial dyes and domestic strains. With extended photodegradation without using any toxic chemical such composite fabric can found extended utilization in textile wastewater treatment with new insight for sustainability need.

Keywords: Metals and alloys, Microstructure, Phase transformation, Bio immobilized, Green processing, Self-cleaning.

GREEN SYNTHESIS OF CHITOSAN @ COPPER NANO-COMPOSITES FOR MULTIFACETED APPLICATIONS

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Owing to the multifaceted applications, the researchers have found great interest in the copper nanoparticles. Ranging from synthesis to applications, these have been widely investigated. The synthesis of copper nanoparticles usually involves the utilization of toxic reducing agents. However due to the increased emphasis on environmental friendliness of processes alternate synthesis routes are explored. The usage of natural extracts as green reducing agents has shown significant potential; however, the weak reduction activities have limited the widespread adoption of natural extracts. In this study we present a novel green synthesis of copper nanoparticles and their multifaceted applications. We demonstrated a facile, biosynthesis, employing cinnamon bark extract as reducing agent. The citric acid was employed as the reaction promoting agent along with the chitosan as capping agent. The addition of citric acid reduced the reaction time significantly. The nanoparticles exhibited a spherical morphology with a particle size ranging from 100 nm to 300 nm. The as synthesized copper nanoparticles demonstrated an excellent catalytic performance coupled with an augmented bioactivity.

Keywords: Nanoparticles, cinnamon bark, bioactivity

SYNTHESIS OF POROUS CARBON AND THEIR APPLICATION IN ENERGY STORAGE DEVICES

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Biomass in nature has diverse microstructures and abundant chemical compositions. There has been a surge of interest in biomass-derived carbon materials due to their adjustable physical and chemical properties, strong chemisorption, environmental friendliness, and low cost. In recent years, research on biomass-derived carbon in energy storage devices, especially lithium batteries, such as (lithium ion, lithium Sulphur, etc.) has emerged endlessly. Our work will introduce the synthesis and application of different types of biomasses in the host and separator of lithium-sulfur batteries. These biomass carbons have their characteristics in structure, composition, and design. In-depth discussion of the actual impact of these characteristics on battery performance. According to the actual industrial application conditions, the practical problems faced by lithium-sulfur batteries are emphasized, and the future application prospects of bio-derived carbon materials are discussed.

Keywords: MOFs, COFs, Biomass, separator

EFFECT OF SURFACE ROUGHNESS ON ADHESIVE BONDING OF POLYMERS AND COMPOSITES

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Adhesive bonding is typically used to join polymers of the same grade and type, but it is now increasingly being employed to join the components of dissimilar polymers and fibre reinforced plastic composites. The quality of a bonded joint is highly affected by the surface roughness and there is a need to investigate its role as an optimized surface roughness not only improves the adhesion strength of the bonded joint but also enhances the strength of the assembly. Lap shear joints of different surface roughness of Polypropylene polymer sheets were assembled by using Henkel Loctite 4090 adhesive. After curing at room temperature, these samples were tested by using a universal testing machine to measure the ultimate tensile strength of the joints. It was observed that the increased surface roughness of polymers helped to increase the joining strength between the adhesively bonded joints, but after a certain point of the surface roughness Ra 1.96 µm the tensile strength between the joints decreases as we increase the surface roughness. Further, numerous high-fidelity numerical simulations were also conducted to examine the deboning phenomenon and effects of adhesive thickness and nonlinear behaviour of adhesively bonded joints.

Keywords: Polypropylene, Adhesion bonding, Surface roughness, Tensile strength, Numerical simulation.

EPOXY/POLYANILINE ELECTRICALLY CONDUCTIVE COMPOSITES FOR ELECTRONIC APPLICATIONS

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This study reports on the electrical conductivity, electromagnetic interference (EMI) shielding, and dielectric properties of conductive epoxy/PAni blend containing different concentrations. Polyaniline (PAni) was synthesized using the oxidative chemical polymerization technique and then dispersed into epoxy resin using a sonication bath. The curing of composites was confirmed through Infrared spectra. Increasing the aspect ratio of PAni in epoxy increased the electrical conductivity and improves the microwave absorption properties of composites in the microwave range (0.1 GHz–20 GHz). Electrical conductivity was measured by using the four-probe method, and the maximum conductivity of the composite was achieved at 3.51 × 10-13 Scm-1 with 30 wt% of PAni. The maximum porosity of the composite with 30 wt% of PAni was 15.5%. EMI shielding was measured by a vector network analyzer (VNA) in the microwave region (0.1 GHz–20 GHz), which gives the maximum value of 63 dB. IR shielding was measured by IR spectroscopy and less than 0.5% transmission was observed in NIR (700 nm–2500 nm) region. The average particle size of PAni is found to be 113 nm. These composites were used as a potential candidate for conductive coatings, EMI shielding purposes, and electronic applications.

Keywords: Composite, Electrical, Epoxy, Polyaniline

EFFECT OF VARIOUS LOADING CONCENTRATIONS OF GRAPHENE NANOFILLERS ON MICROWAVE ABSORPTION PROPERTIES

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The rapid expansion of electronic devices and their haphazard usage has caused a significant dilemma of electromagnetic pollution. The growing prevalence of digital appliances such as mobiles, televisions, computers, and a plethora of other electronic devices has increased the demand for electromagnetic interference (EMI) shielding materials to combat electromagnetic pollution. This electromagnetic pollution is harmful to living organisms and provokes operational dysfunctionalities in military aviation and civil communications. Microwave absorption is important not only for electromagnetic shielding but also for RADAR absorption in stealth applications. Research has been reported to develop aerospace composites containing dielectric and magnetic nano reinforcements. These composites provide shielding in the X-frequency range of 3-8 GHz. However, there are certain challenges such as low EMI shielding effectiveness, lower bandwidth, higher loading concentration of nanofillers, the higher thickness of the composite structure, and lower frequency range due to which these composite solutions are not commercialized.

To combat these issues composite structures are developed which have excellent microwave absorption properties. In the present research work, the effect of nanofillers of graphene was investigated at various loading concentrations. The result shows that there were significant improvements in EMI shielding effectiveness and reflection loss properties of carbon fiber-reinforced composite structures. The EMI SE was improved up to 69.00 dB at the 10% loading concentration of graphene nanofillers while reflection loss properties were improved up to -15.02 dB having the absorptance value of 96.88%. Increasing the loading concentration of graphene nanofillers, EMI SE was increased while reflection loss properties were decreased. The results are commercially viable and can be applied to various electronic instruments for their protection from the harmful impact of electromagnetic radiation.

Keywords: Electromagnetic shielding effectiveness (EMI), Reflection loss, Composites

MACHINE LEARNING BASED PREDICTION OF ELATIC PROPERTIES OF WOVEN FABRIC REINFORED PLASTICS COMPOSITES

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Woven fabric reinforced plastic composites are widely used in automotive and aerospace structures due to ease of manufacturing and high impact resistance. For preliminary design and analysis of the structures, the elastic properties of woven fabric composites are required which are typically estimated through analytical, semi-analytical and numerical means or measured experimentally. In this work, a novel method combining the machine learning technique i.e. Artificial Neural Network (ANN) and the finite-element methods (FEM) based multi-scaling analysis methodology for composites to predict the elastic behavior of woven composites is presented. The method also make use of the datasets generated from analytical formulations and the experimental dataset available in the literature to improve the predictions. Moreover, the effects of the plain-, twill- and satin-weave patterns and the yarn undulation on the elastic properties of woven fabric are also examined.

Keywords: Machine learning, Multi-scale analysis methodology, Homogenization, Woven fabric reinforced plastic composites.

SILVER PLATES STRETCHABLE ELASTOMERIC ELECTRODES FOR ELECTROTHERAPY APPLICATIONS

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The objective of present study was to develop multifunctional and wearable electrically conductive electrodes for TENs application, with acceptable hygienic properties by silver deposition. The electrodes were developed in two stage. At first conductive particles were dispersed into flexible elastomer, then silver electroplating was performed. Dynamic light scattering, XRD and SEM analysis were employed to study the morphology of developed electrodes. To improve the properties of electrode (when it is subjected to various movement of human body), the conductive elastomers were subjected to repeated extension and change in resistivity with stretch was observed. By increasing the degree of extension, very small change in electrical resistance was observed. So, it can almost be considered a constant value in the stretch range of 0–60%. The electrical resistance increased after 70% of stretch. However, the elastomers resistivity was well maintained after repeated extension even over 100 cycles. Furthermore, there was insignificant change in resistivity with time at constant current. Moreover, the role of deposited silver particles on hygienic properties (antibacterial, antifungal, toxicity, and antiviral properties) was examined against different pathogens. At the end, the durability of developed electrodes and electrical properties were examined against several washing cycles. The electrodes showed good retention of the particles, proved by SEM microstructures and small loss in the conductivity and hygienic properties of the material after washing.

Keywords: Silver electroplating, comfort, stretchability, conductive electrodes, hygienic electrotherapy, antimicrobials

EXPLORATION OF THE DESERT LOCUST AS A CHITINOUS SOURCE

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Chitin is the second most abundant natural polymer after cellulose. It is a major structural component of the exoskeleton of invertebrates and the cell wall of fungi. Chitosan, the deacetylated derivative of chitin, has a great benefit (biological activities including antifungal and antibacterial properties, stimulation of defense reactions in plants…). The worldwide demand for chitosan is growing rapidly due to its many applications, for example in water treatment, agriculture, food, medicine, cosmetics, and textiles.

Although the Desert Locust is known to be a rich source of protein. We were interested in exploring it as a chitinous source to assess the content and quality of the chitin it presents. In this work, we present the results obtained in relation to:

The chitin extraction from the locust and other parts, the reaction conditions used, and the chitin contents obtained for each part. The preparation of the corresponding chitosans according to the processes of Broussignac (KOH in an anhydrous medium) and that of Kurita (NaOH in aqueous solution). The chitins and chitosans prepared are characterized by 13C NMR CP/MAS, Infra-red, X-ray diffraction, analysis of CHNS elements, scanning electron microscopy (SEM), energy dispersive X-ray spectroscopy (EDX), acid-base titration and viscometry.

The chitin content varies between 9% and 12%, with molar masses which vary between 13000g/mol up to 852000g/mol and crystallinity index ranging from 54% up to 72%. These chitosans have a DA varying between 0% and 15% with molar masses between 15000g/mol up to 112000g/mol.

Keywords: Chitin, Chitosan, Desert Locust, Extraction, Deacetylation

DEVELOPMENT OF POLYMER-BASED MEMBRANE MODULE FOR THE SEPARATION OF CO2 FROM N2

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The combustion of fossil fuels is the primary source of CO2. Deforestation, terracing for agriculture, and soil deterioration are a few examples of indirect human-induced effects on forestry and other land uses that can emit CO2. Chemical and Petrochemical industries also act as fixed sources of CO2 emission, whereas, vehicles act as mobile sources of CO2 emission. These are the main causes of global warming on Earth. Natural gas is one of the most important fossil fuels and consists of many impurities such as CO2, N2, H2S, etc. These impurities must be removed from natural gas before its utilization. Nowadays, a sizable amount of the world's energy is used for operations of separation and purification, the majority of which are inefficient primarily because of thermodynamic restrictions. As an alternative, membrane-based technologies have increased since membranes may combine energy-efficient operation, economic effectiveness, low maintenance, reliability, and molecularly selective separation. Depending upon the membrane selectivity and permeability, it separates the required gas component from the gaseous mixture. According to our proposal, facilitated transport membranes will manufacture into spiral-wound modules after being scaled up for Carbon dioxide separation from Nitrogen. A multi-leaf rolling method employing a carrier layer will be used to suitably expand the area of the membrane in a respective module, and the fabrication methods will be well described. The necessary gas components (CO2) will be separated from nitrogen using gas permeation technology. Selectivity and Flux will be the main constituents, which will be improved. Thus, the gas separating spiral wound module will be fabricated by optimizing its operating conditions and efficiency, by using the Gas Permeation technique.

Keywords: global warming, selectivity, permeability, spiral-wound module, gas permeation techniques

INFLUENCE OF INLAY AND STACKING SEQUENCE ON FLEXURAL BEHAVIOURS OF KNITTED REINFORCED SMART COMPOSITES

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Knitted reinforced composites engineered using inlay architectures are primarily focused on hi-tech applications, owing their satisfactory mechanical characteristics. Structural health monitoring of fiber reinforced composite materials is also an area of interest in this era. Hence the study focuses on development of knitted reinforced smart thermoset composites having ability to sense damages happening in them. Knitted reinforcements were developed using inlay patterns of straight passing yarns after each third, sixth, and ninth knitted course respectively. Carbon was employed as inlay yarn, and base knitting was performed using polyester. Two different stacking sequences comprising single and multiple stimuli layers were used for composites manufacturing. Flexural characterization was performed with real time electrical resistance monitoring to evaluate the self-diagnostic capability of smart composites. Induced cracks during flexural loading varied the electrical resistance values making the smart composites viable solution for structural health monitoring of sensitive composites constructions.

Keywords: Knitted reinforcements, inlaid structures, smart composites, and structural health monitoring

STUDY ON PRESSURE TRANSMISSION PATTERNS OF MEDICAL COMPRESSION TEXTILES WITH MINIATURIZED AIR BLADDERS

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Compression therapy, either active or passive, is considered as the cornerstone of treatment for all types of Chronic Venous Disease (CVD) which is the most prevalent vascular disease affecting the lower extremities. However, most of the existing medical compression textiles inherit a limitation of applying uniform pressure around the lower limb circumference. Previous research has shown that this limitation could be overcome by applying a radial force in response to a pressure exerted by an air volume trapped inside a miniature bladder. Thus, this study analysed the pressure transmission characteristics of the miniature bladders via numerical modelling, and laboratory experiments. A repeating unit of the compression textile consists of three hexagonal shaped miniaturised bladder unit was used for the analysis. The pressure transmission characteristics of miniaturized air bladders were investigated for a variety of size and thickness parameters using numerical simulations. It was observed that the percentage of pressure transmission increased as the bladder size increased while it was decreased as thickness increased. Furthermore, the findings of the study revealed that around 55% of the applied pressure into the miniaturised bladder was transmitted on to the treated surface while only around 40% of the supplied pressure was transmitted on to the skin layer. Both experimental results and numerical simulation showed similar results where the average interface pressure of the simulations had more than 95% agreement with the experimental pressure values obtained from AMI sensors.

Keywords: chronic venous disease, compression therapy, finite element analysis, active compression, miniaturised bladders

ROLE OF CARBON DUAL FILLERS ON THERMO-MECHANICAL PERFORMANCE OF POLAR XNBR RUBBER

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Improvement in mechanical properties of the rubber for potential mechanical performance in the composite is a key focus of researchers in recent years. In this article, the effect of changing the carbon nanofiller content in the carboxylated nitrile butadiene rubber (XNBR) on thermomechanical performance has been investigated. Dual fillers, high abrasion furnace grade (N330) and fast extrusion furnace grade (N550) carbon fillers are used for rubber with different filler contents by weight (D1, D2, D3) using an open two roll mill. The tensile tests were performed at a strain rate of 200 mm/s using universal testing machine (Zwick Z100). The drop weight test was performed at an energy level of 10 J. The rubber with high carbon filler content (D3), shows high energy absorption during impact (298 N) and drop weight tests. During the thermal-mechanical test, D3 sample shows high penetration resistance that varies with temperature and less dimensional change in comparison with D1 and D2. The prospective future work includes using the produced optimized vulcanized rubber as a matrix in fiber-reinforced composites and mechanical characterization.

Keywords: Thermoset rubber, carbon fillers, thermo-mechanical characterization, Charpy, drop weight impact.

MAGNETO DIELECTRIC COUPLING IN IRON OXIDE THIN FILMS- EFFECTS OF MICROWAVE POWER

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Microwave assisted sol-gel route is used to synthesize iron oxide thin films with microwave powers of 180W-1000W. Ferromagnetic response of sol is observed at 360-450W, 630W and 720W powers, while super paramagnetic behavior is obtained at 810W-1000W. Films prepared using sols synthesized at 180W, 270W and 540W exhibit amorphous nature. a-Fe2O3 phase is observed at microwave (MW) power of 360W-450W. γ-Fe2O3 phase is observed at MW of 630W and 720W and Fe3O4 phase is observed at 810-1000W. Highest saturation magnetization of 45.23emu/cm3, 248.403emu/cm3 and 419.43emu/cm3 are observed for a-Fe2O3, γ-Fe2O3 and Fe3O4, respectively. The transition of Verwey in Fe3O4 thin film is observed at ~115.2 K while no such variation is observed for γ-Fe2O3 phase. Further, a-Fe2O3 phase shows spontaneous magnetization at low temperatures from FC/ZFC curves. Highest dielectric constant of ~54.26, 84.19 and 121.34 (log f = 5.0) are observed for a-Fe2O3, γ-Fe2O3 and Fe3O4, respectively. Magneto dielectric coupling (MDC) of ~ -3.9%, -5.1% and -7.8% is obtained for a-Fe2O3, γ-Fe2O3 and Fe3O4 thin films. As Fe3O4 phase is found to exhibit peculiar MDC with respect to other phases so the Fe3O4 phase reveals exotic magnteodielectric coupling anomalies.

Keywords: (Microwave radiations, Thin Films, Magnetic, Dielectric)

IMPACT OF GLASS FIBER ORIENTATION ON MECHANICAL PROPERTIES OF COMPOSITE MATERIALS

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Composites are a well-demanded material in the automobile and aerospace industry due to their high strength-to-weight ratio. Glass Fiber Reinforced Polymers (GFRP) are preferable engineering materials where high material and flexural strength are required. It is stated that highly aligned continuous glass fibers modified thermoset polymeric materials are used for structural applications. There are different manufacturing processes, but the hot press molding process is recommended for high production volume due to simple processing and less curing time required for glass fiber-epoxy interface adhesion. It is used to fabricate large and thick parts. The mechanical properties of a product are highly dependent on the material properties of the fiber reinforcement and its orientation. The aim of this work is to evaluate the mechanical strength of semi-finished pre-impregnated glass fibers in epoxy with different orientational directions. It is observed that the Ultimate Tensile Strength (UTS) and Elastic Modulus (E) depend on the alignment of reinforced fiber and the type of resin used for bonding. Further, these results are compared with simulated results compiled in the ANSYS workbench and tried to investigate the difference and proper reasons.

Keywords: Glass Fiber Reinforced Polymer (GFRP), Thermoset, Curing Time, Ultimate Tensile Strength (UTS), Elastic Modulus (E).

A REVIEW ON THE APPLICATIONS OF NANOCELLULOSE

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Nanocellulose is cellulose that has been shaped into nanostructures, or components, with a minimum one-dimensional size of 100 nm. These nanostructures include nanofibrils, which are found in bacterial cellulose, nanofibers, which are more common in electrospun matrices, nanowhiskers, nanocrystals, nanorods, and nanoballs. Larger two-dimensional (2D) and three-dimensional (3D) nano-, micro-, and macro-structures, such porous macroscopic matrices, membranes, films, and nanoplatelets, may be made by further combining these structures. The four main sources of nanocellulose are plants (trees, shrubs, herbs), bacteria (Gluconacetobacter), animals (Cladophora), and algae (Cladophora) (Tunicata). Nanocellulose is being used in a variety of practical applications, including product packaging, papers and paperboard, the food and pharmaceutical industries, hygiene products, paints, skin care products, and sensors. This work is significant because it offers a full description of the several industrial fields where the newly found nanocellulose might be used as a new source of raw materials. Nanocellulose may be used in the following industries such as biomedical engineering, electronics, the textile industry, energy, biomaterials, and systems for removing contaminants.

Keywords: Nanocellulose; cellulose; applications; mechanical pulping

BLEND MEMBRANES COMPRISING OF POLYETHERIMIDE AND POLYVINYL ACETATE FOR METHANE ENRICHMENT

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Nanocellulose is cellulose that has been shaped into nanostructures, or components, with a minimum one-dimensional size of 100 nm. These nanostructures include nanofibrils, which are found in bacterial cellulose, nanofibers, which are more common in electrospun matrices, nanowhiskers, nanocrystals, nanorods, and nanoballs. Larger two-dimensional (2D) and three-dimensional (3D) nano-, micro-, and macro-structures, such porous macroscopic matrices, membranes, films, and nanoplatelets, may be made by further combining these structures. The four main sources of nanocellulose are plants (trees, shrubs, herbs), bacteria (Gluconacetobacter), animals (Cladophora), and algae (Cladophora) (Tunicata). Nanocellulose is being used in a variety of practical applications, including product packaging, papers and paperboard, the food and pharmaceutical industries, hygiene products, paints, skin care products, and sensors. This work is significant because it offers a full description of the several industrial fields where the newly found nanocellulose might be used as a new source of raw materials. Nanocellulose may be used in the following industries such as biomedical engineering, electronics, the textile industry, energy, biomaterials, and systems for removing contaminants.

Keywords: Nanocellulose; cellulose; applications; mechanical pulping

SIMULATIONS OF MULTIWALLED CARBON NANOTUBES TO DETECT PROPANE AND BUTANE GASES FOR WEARABLE GAS SENSOR APPLICATIONS

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Recent advancements in the field of nanotechnology have urged researchers to explore the prodigious potential of nanomaterials to forge highly efficient, reliable, cheap, and, portable gas sensors [1-2]. Carbon nanotubes (CNTs) have emerged as an exceptional candidate for gas sensing application due to their enormous exceptional attributes including fast response time, high adsorption area, selectivity, and sensitivity [3-4]. CNTs may be categorized as single-walled carbon nanotubes (SWCNTs) and multi-walled carbon nanotubes (MWCNTs) [5]. In this paper, the simulations of MWCNTs have been done to detect the flammable household gases (i.e. propane and butane) for wearable gas sensor application. The electronic attributes like the density of the states, electronic transmission spectrum, and current-voltage curves of the MWCNT in the proximity of target gases have been calculated. A significant change in the electronic properties of MWCNT at its exposure to propane and butane gases has been observed. The changes in the electronic properties of MWCNT in the presence of target gases can be used as a signature signal to detect the target gases. The simulation results reveal that the proposed structures are a suitable candidate for the development of wearable gas sensors for the leakage detection of propane and butane gases. Our near future intention is to deposit MWCNTs on textile fibers using electrospinning technology for the manufacturing of wearable gas sensors.

Keywords: Carbon Nanotubes, Wearable Sensors, Gas Sensors, Propane, Butane

COMPARATIVE EVALUATION OF MECHANICAL PROPERTIES OF SHORT ARAMID FIBER ON THERMOPLASTIC POLYMERS

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This study investigated the mechanical performance of short aramid fiber on polypropylene, polyethylene, polyamide 6, and polyamide 12. Used the extrusion method in the production of samples of the composites. Tensile, three-point bending, drop weight and hardness tests of the composites were carried out. As the fiber volume fractions increased, the mechanical properties of the composites improved, but the most efficient fiber fractions for each matrix changed. To analyze the performance of the fibers in the matrix on the composites, Scanning Electron Microscope (SEM) images of the fractured surfaces as a result of tensile and drop weight tests were examined. As the fiber volume fractions increased, the fiber deformation increased, and as a result, the mechanical performance of the composites was adversely affected. ANOVA analysis and F test were performed using Signal/Noise values to analyze the effect of experimental parameters on output values in detail. Finally, an optimization study was carried out to express the experimental results mathematically.

Keywords: Aramid fiber, polymer-matrix composites, mechanical properties, ANOVA analysis, experimental data

COMPARISON OF NATURAL FIBERS' PROPERTIES USED IN COMPOSITE REINFORCEMENT

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The development of natural fibers is vital due to environmental reasons and the use of natural fibers has recently received increasing attention. Jute, hemp, linen, sisal, and banana fibers are commonly used worldwide and have a vast range of textile applications. These fibers are also abundantly available in many countries like Pakistan, India, China, Turkey, and the USA. This study aims to investigate the physio-mechanical properties of the above-mentioned natural fibers and their comparative analysis. All these fibers were obtained from the turkey-based textile industry. The surface morphology of these natural fibers was investigated by using scanning electron microscopy, which showed that banana fibers and sisal fibers are hollow as compared to other fibers. The mechanical properties were tested by using a single fiber tensile testing machine. Sisal fiber showed the maximum breaking strength, and banana fiber showed the maximum elongation%. Functional groups of these natural fibers were examined by Fourier transform infrared spectroscopy (FTIR). The thermal behavior of these natural fibers was studied through differential calorimetry spectroscopy (DSC) and Thermogravimetric analysis (TGA). To determine the chemical composition of these natural fibers Energy Dispersive X-Ray Analysis (EDX) and Raman analysis were also performed.

Keywords: Natural fibers, Mechanical properties, SEM, FTIR, TGA, DSC, EDX, Raman analysis

DOPE DYED POLYURETHANE ELECTROSPUN NANOFIBRES

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Electrospun polyurethane nanofibrous mats are used in stretchable, flexible, memory, filtration membrane, protective clothing, drug delivery, and other technical materials. Lately, their potential for aesthetic purposes has been explored, and various dyeing techniques, as an additional process, and the environmental impact has been reported. Herein, the dope dyeing technique of polyurethane electrospun nanofibrous mats with disperse dyes is reported as a part of the electrospinning process. Dope dyeing when compared to other techniques consumes lesser time, reduced cost and environmental impact, and produces better color and uniformity. The preparation of the dope solution, electrospinning, and post-dye curing processes was optimized for producing the colored electrospun polyurethane nanofibrous mat. Dope-dyed electrospun polyurethane nanofibrous mats produced good colored yield and colorfastness results. Moreover, the morphology of undyed and dope-dyed electrospun polyurethane nanofibrous mats was similar as observed in the SEM analysis, and the presence of the dye molecules was evident in the FTIR analysis.

Keywords: Electrospun polyurethane nanofibrous mats, Dope Dyeing, Disperse Dyes, Nanotechnology, Electrospinning technique, Polyurethane polymer

DESIGN, PRODUCTİON AND INVESTIGATION OF BALLİSTİC PROPERTİES OF COMPOSITE PANELS FOR LEVEL III AND LEVEL IV BALLISTIC PROTECTION

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In this study, the ballistic resistance, protection level and production parameters of different composite plates were investigated comparatively and their usability in level III and level IV armors was investigated. For level III protection, composite panels are produced by heat pressing method at different pressures, and level IV composites are produced by reinforcing the back parts of ceramic plates of different thicknesses with different composite materials. Produced composite panels were subjected to ballistic tests in accordance with NIJ standards. As a result, it was observed that the samples produced at 90 bar pressure in level III protective panels were punctured in ballistic tests, there were delaminations between the layers as a result of the ballistic test in the panels produced at 140 bar pressure, and there was no puncture in the panels produced at 250 bar pressure, and the depth of trauma decreased to a minimum. Dry and wet ballistic tests were carried out on Level IV panels, and according to these test results, it was determined that K-flex reinforced ceramics did not have any punctures, had higher ballistic properties than UD H62 reinforced ceramics and aramid reinforced epoxy ceramic panels, and were 6% more advantageous in weight.

Keywords: Armor vest, Ballistic, Composite panel, Aramid

ELECTROMAGNETIC INTERFERENCE SHIELDING OF HIGH-DENSITY POLYETHYLENE NANOCOMPOSITES

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Electromagnetic radiation interference pollution highly affects the modern era miniature technology by decreasing the functionality and reliability of electronic devices. Shielding materials have been used to overcome the effects of electromagnetic interference. Polymeric nanocomposites with low filler ratio is highly appealing for the application of EMI shielding. Two-dimensional class of materials including graphene and other layered materials has been extensively and effectively used as nano-filler in polymer nanocomposites. In the research work presented here MoS2 nanosheets were prepared by liquid phase exfoliation and were used to fabricate high density polyethylene (HDPE) nanocomposites by melt mixing method. These HDPE/MoS2 nanocomposites were prepared with filler ratio of 0.8, 1.2 and 2 wt.%. The dispersion of 2D MoS2 in the HDPE matrix was confirmed by XRD, FTIR and SEM analysis. S-parameters obtained from network analyzer shows the shielding effectiveness of ~-20.5 dB in X band, which is commercially acceptable value for shielding devices. Defects produced by MoS2 exfoliation process act as dipoles and helped in the absorption of electromagnetic radiation for the shielding purpose. The extreme thinness and high specific surface area of MoS2 nanosheets could increase the propagation paths for the incident waves inside the samples compared with MoS2-Bulk.

Keywords: High density Polyethylene, MoS2 nanosheets, polymer nanocomposite, EMI shielding, X band shielding effectiveness

EMI SHIELDING CHARACTERISTICS OF AG-PVDF NANOCOMPOSITE FILMS IN IR REGION

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Silver nanoparticles (AgN) were synthesized by Co-Precipitation method. The microstructure characterization and performance testing were carried out using scanning electron microscopy (SEM), showing particle size approx. 51nm, X-ray diffraction (XRD), confirming fabrication of silver nanoparticles (AgN) and partical size aprrox 53nm, and particles size analyses (PSA) facilities. The experimental results indicate that the diameter of Silver nanoparticles(AgN) was approximately 56 nm. Polymer-based nanocomposite films around 0.25 mm were prepared by dispersing silver nanoparticles(AgN) with different wt% in PVDF and analyzed for DC conductivity and electromagnetic interference (EMI) shielding in two different regions of the electromagnetic spectrum i.e. near-infrared (NIR) (700–2500 nm) and microwave region (0.1–20 GHz). Dielectric properties like dielectric constant and dielectric loss also suggested the high EMI shielding effectiveness. Less than 1% transmission was observed in the whole NIR region by using high wt% of silver NP and less than −50 dB total shielding effectiveness was observed in the whole microwave region (0.1–20 GHz).

Keywords: PVDF, EMI Shielding, Filtration, Nanoparticles

FABRICATION AND INVESTIGATION OF MECHANICAL PROPERTIES OF POLYMERNANOCOMPOSITES REINFORCED WITH 2D MOS2 LAYERS

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Silver nanoparticles (AgN) were synthesized by Co-Precipitation method. The microstructure characterization and performance testing were carried out using scanning electron microscopy (SEM), showing particle size approx. 51nm, X-ray diffraction (XRD), confirming fabrication of silver nanoparticles (AgN) and partical size aprroximately 53nm, and particles size analyses (PSA) facilities. The experimental results indicate that the diameter of Silver nanoparticles(AgN) was approximately 56 nm. Polymer-based nanocomposite films around 0.25 mm were prepared by dispersing silver nanoparticles(AgN) with different wt% in PVDF and analyzed for DC conductivity and electromagnetic interference (EMI) shielding in two different regions of the electromagnetic spectrum i.e. near-infrared (NIR) (700–2500 nm) and microwave region (0.1–20 GHz). Dielectric properties like dielectric constant and dielectric loss also suggested the high EMI shielding effectiveness. Less than 1% transmission was observed in the whole NIR region by using high wt% of silver NP and less than −50 dB total shielding effectiveness was observed in the whole microwave region (0.1–20 GHz).

Keywords: PVDF, EMI Shielding, Filtration, Nanoparticles

FABRICATION OF PVDF BASED ELECTRICALLY CONDUCTIVE MEMBRANE (ECM) FOR WATER FILTRATION APPLICATION AND ANTIBIOFOULING BEHAVIOR STUDY

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Poly aniline (PANI) was in-situ polymerized with Silver nanoparticles to create modified Ag-PANI and blended with PVDF to endow a nanocomposite membrane for wastewater treatment with improved hydrophilicity and anti-biofouling behavior. The solvent free phase inversion method was employed for membrane fabrication using. The characteristics of Ag-PANI-doped membranes were investigated through thermal analysis, contact angle, SEM, FTIR, and anti-biofouling property. Results indicated that anti-biofouling property and hydrophilicity of Ag-PANI nanocomposite membranes were enhanced with addition of hydrophilic nanomaterials in comparison to pristine PVDF membrane. FTIR analysis confirmed the successful decoration of Ag-PANI groups on PVDF membrane surface while revealing its morphological properties through SEM analysis. Thermal analysis performed using DSC confirmed the increase in thermal stability of Ag-PANI-PVDF membranes than pure PVDF membrane. Conductivity of membranes was investigated by determining their Zeta potential. Filtration rates calculated with applied voltage confirmed that modified membranes had better flux, BSA rejection and better anti-fouling behavior.

Keywords: PVDF, Anti-biofouling, ECM, Membrane, Filtration, Nanoparticles

GRAPHENE OXIDE REINFORCED CARBON FIBRE/EPOXY-BASED HYBRID COMPOSITES FOR AEROSPACE APPLICATIONS

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Carbon fibre reinforced composites (CFCs) have gained utmost importance in automobile, aerospace and military applications due to their excellent mechanical properties and high strength to weight ratio. This research aims to synthesize carbon fibre/epoxy-based hybrid composites with further improved mechanical properties. Carbon fibre/epoxy composites were developed by conventional hand layup technique. Graphene oxide (GO), polyaniline (PANI) and magnetite (Fe3O4) magnetic particles were introduced to enhance mechanical properties of composites. GO was synthesized by improved Hummers' method. PANI and Fe3O4 nanoparticles were synthesized by oxidative polymerization of aniline monomer and chemical precipitation method, respectively. Two mixing techniques, mechanical mixing (MM) and vacuum centrifuge mixing (VCM), were used to study the effect of mixing technique on mechanical properties of composites. Furthermore, effect of GO, PANI and Fe3O4 content was studied by varying wt. % of different nanofillers. Tensile testing as per ASTM D3039 was carried out to evaluate mechanical properties of composites. Mechanical testing revealed that neat epoxy composite without addition of nanofiller showed maximum ultimate tensile strength (UTS) of ca. 53 MPa. CFC produced by MM having 0.4 wt. % of GO exhibited UTS of ca. 292 MPa compared to ca. 264 MPa of the corresponding composite produced by VCM. The UTS of CFC with the fixed GO content of 0.4 wt. % was improved by the addition of 0.5 wt. % PANI and Fe3O4 addition resulting in maximum UTS of ca. 275 MPa and 224 MPa, respectively. GO, PANI and Fe3O4 reinforced CFC showed ca. 5.5 x, 5.2 x and 4.2 x increase in UTS, respectively, compared to neat epoxy CFC. Mechanical testing revealed that incorporation of GO, PANI and Fe3O4 resulted in considerable increase in mechanical properties of CFCs and these hybrid composites are suitable to be used as structural material for automobile and aerospace application. This research provides a novel strategy to improve mechanical properties of CFC.

Keywords: Carbon fibre reinforced composites; hand layup method; graphene oxide; magnetic particles; polyaniline; mechanical properties

A REVIEW ON DIFFERENT PULPING METHODS: CHEMICAL, MECHANICAL AND CHEMI-MECHANICAL PULPING

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Depletion of forest resources due to the increase in global population calls for the demand for paper and pulp-derived products as alternative resources for the pulp and paper industry. Therefore, choosing the appropriate pulping technique, which is determined by the type of fibre, the finished product, and economic factors, is an important step. The process of "pulping" involves subjecting wood or other biomass material to some degree of chemical or mechanical activity to separate the fibres, either singly or in bundles, from an encasing matrix. Various pulping methods are introduced and evolved which has proven that demand for pulp and paper is still going strong. There are three categories of pulping processes: (1) chemical, (2) chemi-mechanical, and (3) mechanical pulping. These are in arrange of increasing the mechanical vitality required to separate fibres and diminishing the dependency on chemical action. Mechanical pulping was found to produce higher pulp yield per unit volume compared to chemical pulping. However, the mechanical pulping process uses intensive energy consumption and produces paper with a higher colour reversion rate due to the high content of lignin, whereas chemical pulping needs excessive chemicals to degrade and dissolve the lignin, which the end leaves high-strength cellulose fibres from the cell wall. Consequently, chemi-mechanical pulping method is invented in order to overcome the limitation offered by the other two methods. Thus, this study focuses on the past and recent evolution made on the three different pulping methods by the pulp and paper industry.

Keywords: pulp and paper, chemical pulping, chemi-mechanical pulping, mechanical pulping

FABRICATION OF NOVEL CHITOSAN BASED THERMOSENSITIVE HYDROGELS FOR EFFECTIVE ANTIBACTERIAL ACTIVITY

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Thermosensitive based chitosan hydrogels have been widely utilized in drug delivery and soft tissue regeneration. Chitosan-based hydrogel containing ε-poly-l-lysine (PL) have been synthesized in two different concentrations and were evaluated with the aim to enhance the antimicrobial efficiency of such hydrogels in biomedical field. The characteristics of the prepared hydrogels have been analysed via antibacterial activity, swelling studies and contact angle measurement. The antibacterial study was carried out to evaluate the bacterial inhibition capability against two strains E. coli and S. aureus, hydrogel showed favourable results along with the addition of PL content i.e. CS.PL (20%) revealed a zone of 12.5 mm. The swelling study demonstrated absorption efficiency of CS.PL hydrogels, a maximum swelling ratio of 140% by CS.PL(20%) and contact angle measurement results demonstrated the hydrophilic nature of the prepared hydrogels. These studies supported the utilization of the synthesized CS.PL hydrogels in antimicrobial application, ensuring better migration, proliferation and adhesion to the cell.

Keywords: Chitosan, hydrogel, thermosensitive, antibacterial, Wound healing.

NUMERICAL MODELING OF PARA-ARAMID REINFORCED COMPOSITE PLATE (INVESTIGATING EFFECT OF 3D REINFORCEMENT ON PROJECTILE PENETRATION)

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Abstract

Using combination of 3D interlock woven para-aramid reinforcement and vinyl ester resin, composite plates were produced for mechanical testing. Furthermore, through advanced numerical modeling with Ansys Explicit Dynamics software, a comprehensive evaluation was conducted to analyze their performance capabilities against projectile penetration. Commercial para-aramid was used for manufacturing of 3D woven interlock reinforcement. Vinyl ester was used as matrix and 3D woven interlock fabric were produced having 15 ends/cm and 61 picks/cm. Finite element analysis was conducted using ANSYS explicit dynamics to model a composite sample subject to ballistic impact. Domain specifications, meshing parameters and boundary conditions were defined before assigning appropriate projectile mechanisms for the simulation. The findings suggest significant improvement in material strength and better structural integrity for 3D woven reinforced composites.

POLYMERIC MEMBRANE FOR WASTEWATER TREATMENT APPLICATIONS

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Polymers, a class of materials consisting of multiples of monomers to form larger molecules, can be either naturally occurring or artificially produced. Interestingly, numerous parts of a living organism are polymers and many strategies have been employed to develop their potential as functional material for a wide range of applications such as foams, coatings, elastomers, adhesives, fillers and composites. Many researchers are investigating the feasibility of using polymeric materials to manufacture membranes for numerous applications due to the wide variety of barrier structures and characteristics polymeric composites can design. Despite lacking mechanical, thermal, and chemical stability, polymer membranes are widely used in wastewater treatment. Employing these advanced materials for water permeation can boost membrane efficiency which a is simple preparation, cost-effectiveness, high contaminant removal efficiency, compactness, reduced energy, flexibility, and low working temperature, which requires less rigid membrane fabrication materials. Apart from the obvious requirement for robust and efficient polymeric membranes for the system, the permeability of the membrane is a significant factor that should be tailored in water treatment applications. The membrane materials, shape, cross-section, and fabrication methods have primarily attributed the performance of the membranes. Therefore, the utilization of some polymeric materials and preparation methods affected the permeability, selectivity, and rejection of membranes for wastewater treatment applications is discussed.

Keywords: Polymer, membrane filtration, wastewater treatment, barrier structure.

DEVELOPMENT OF NON-WOVEN CONDUCTIVE FABRIC COMPOSITE FOR SHIELDING AGAINST EMI AND THERMAL IMAGING

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The EMI shielding characteristics of nylon-based composites was studied when coated with polyaniline (PANI). The conductive coated fibers were made using in-situ polymerization of PANI. Afterwards, the non-woven fabric-based composite was formed through compression molding using PVC as matrix. Various techniques were utilized for characterization of the prepared composites like SEM, DC conductivity, NIR spectroscopy, Impedance EMI shielding and Thermal imaging. The fabric's capacity to deflect EM waves made it possible to conceal a person from a thermal imaging camera, which relies on infrared radiation given off by the body to take pictures. The dielectric properties were determined using impedance analyzer. The EMI shielding was measured in two different regions that are Near infrared (NIR) (700 nm – 2500 nm) and microwave region (0.1 GHz to 13 GHz). The composites showed enhanced conductivity and EMI shielding. The results revealed less than 1% transmittance in NIR and more than 30 dB shielding effective ness was observed in whole microwave region.

Keywords: EMI shielding, DC conductivity, PANI, Nylon, Fiber reinforced composites, Thermal imaging

FABRICATION OF ELECTRICALLY CONDUCTIVE FIBERS FOR PROTECTION AGAINST THERMAL IMAGING AND EMI

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Through in-situ polymerization, polyaniline (PANI) was effectively chemically coated onto the surface of polyester fibers (PEF). Using a hot press and polyvinyl chloride as a binder, a non-woven fabric was created. Initial XRD and SEM analyses verified the effective synthesis of PANI and the presence of PANI coating on the surface of PEF. Both fibres with and without coatings had their DC conductivity assessed, and the results revealed a significant variation in DC conductivity value. Nearly 0.1 S/cm is reached from the insulative zone. The modulus and tensile strength both seemed to rise from 0.5 MPa to 2.5 MPa to 0.4 MPa, respectively. To prevent electromagnetic (EM) radiation, an electrical conductivity is a key prerequisite. The fabric effectively blocks 99.9% of UV and NIR rays. The fabric's ability to block EM waves allowed it to conceal a human body that was producing infrared radiation at a high temperature from a thermal imaging camera, as it uses IR radiation released by the body to capture images. Using impedance analysis, it was possible to evaluate the dielectric characteristics such as the dielectric constant, dielectric loss, and AC conductivity. It is observed that the three values sharply increased between the frequencies of 100Hz and 5MHz. A total SE of about 80 dB was recorded in the same frequency range of 100 Hz to 5 MHz using the dielectric constant and dielectric loss as a calculation method for electromagnetic interference (EMI) shielding effectiveness (SE).

Keywords: EMI shielding, DC conductivity, PANI, Fiber reinforced composites, Thermal imaging

FABRICATION OF PVC-BASED FLEXIBLE NANOCOMPOSITE FILMS BY INCORPORATING AG/TRGO NANOPARTICLES FOR EMI SHIELDING APPLICATIONS

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Ag (silver) nanoparticles were synthesized by the chemical reduction method. Thermally reduced graphene oxide (TRGO) was formed by the thermal reduction of graphene oxide. Ag/TRGO nanoparticles were prepared. PVC-based nanocomposite films containing various amounts (by weight) of Ag/TRGO were fabricated by the solution casting method. Ag/TRGO nanocomposite films with an average thickness of 70 µm were synthesized. For the purpose of characterization of the produced nanocomposite films, a variety of methods, such as particle size analysis, impedance analysis, NIR spectroscopy, scanning electron microscopy, and DC conductivity, were utilized. Particle size analysis indicated that Ag and TRGO NPs with a particle size of 11.7 nm and 8.72 nm were successfully fabricated. Microstructure analysis was done by using scanning electron microscope. Impedance analysis was used to calculate the electromagnetic interference shielding of nanocomposite films. Electromagnetic interference (EMI) shielding was observed in the 100Hz to 5MHz frequency range. Greater than 100 dB total shielding effectiveness was achieved. In the near infrared region (700-2500 nm), less than 0.1% transmission was observed by using a high wt% of Ag/TRGO nanoparticles.

Keywords: EMI Shielding, DC conductivity, PVC films, TRGO, Silver nanoparticles, Nanocomposites, Solution casting.

FABRICATION OF PVC-BASED FLEXIBLE NANOCOMPOSITE FILMS BY INCORPORATING PANI/GRAPHITE POWDER NANOPARTICLES FOR EMI SHIELDING APPLICATIONS

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Electrically conductive polymeric nanocomposite films were fabricated using polyvinylchloride (PVC) as a matrix. PANI NPs were formed by the chemical oxidative method. PANI/Graphite powder NPs were synthesized to incorporated them in PVC films as a conductive filler. By using the solution casting technique, PVC-based nanocomposite films with varying amounts (by weight) of PANI/Graphite powder were fabricated. PANI/Graphite powder nanocomposite films with an average thickness of 70 µm were synthesized. For the characterization of fabricated nanocomposite films different methods, such as particle size analysis, impedance analysis, NIR spectroscopy, scanning electron microscopy, and DC conductivity, were employed. Microstructure analysis was done by using scanning electron microscope. Particle size analysis indicated that PANI NPs with a particle size of 51.2 nm were successfully fabricated. Impedance analysis was used to calculate the electromagnetic interference shielding of nanocomposite films. Electromagnetic interference (EMI) shielding was observed in the 100Hz to 5MHz frequency range. Greater than 50 dB total shielding effectiveness was achieved. In the near infrared region (700-2500 nm), less than 0.2% transmission was observed by using a high wt% of PANI/Graphite powder nanoparticles.

Keywords: EMI shielding, PANI, Nanocomposites, Graphite powder, solution casting, PVC films.

IRON MANGANESE OXIDE NANOPARTICLES AND ITS COMPOSITE FOR CATALYTIC AND FUEL ADDITIVE APPLICATIONS

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Present research work includes the synthesis of novel polyaniline-iron manganese oxide (PANI-FeMnO3) nanocomposite via chemical polymerization of aniline in the presence of oxidizing agent with FeMnO3 bimetallic nanoparticles. FeMnO3 bimetallic nanoparticles are prepared by a temperature-controlled solvothermal method. SEM and STEM analysis provided the interconnected fibrous network of nanocomposite and oval-shaped morphology of FeMnO3. Characteristics peak at 1543cm-1 in the FTIR patterns of PANI and PANI-FeMnO3 pointed out the presence of quinoid and benzenoid rings. Highly crystalline nature of FeMnO3 and amorphous nature of polymer nanocomposite is confirmed by XRD analysis. This study is emphasized on the comparative investigation of catalytic efficiency of the FeMnO3 bimetallic nanoparticles and PANI-FeMnO3 nanocomposite. Catalytic reduction of organic dyes and nitroarenes is performed. Different parameters such as apparent rate constant (kapp), reduction time, percentage reduction and reduced concentration are studied to assess the catalytic activity of both catalysts. Among all substrates, kapp of 2,4-dinitrophenol is highest with polymer nanocomposite. Conducting polymer support and positive surface charge seemed to enhance the efficiency of PANI-FeMnO3 nanocomposite. The efficiency of both products as nanoadditives is also assessed by investigating the various parameters of commercial diesel with varying dosages. The decrease in the cloud and pour point, flash and fire point and surface tension as well as increase in the kinematic viscosity and specific gravity suggested that fuel efficiency is greatly enhanced by increasing the dosage of nanoadditives. The results of this study indicated that PANI-FeMnO3 nanocomposite is better catalyst and nonoadditive than FeMnO3 bimetallic nanoparticles.

Keywords: Polymer nanocomposite, catalysis, reduction, pseudo first order kinetics, nanoadditive, fuel efficiency

STRUCTURAL APPLICATIONS OF FIBRE REINFORCED POLYMER COMPOSITES IN MARITIME APPLICATIONS

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This presentation will provide details of our recent development on the use of fibre reinforced polymer matrix (FRP) composites in maritime applications as part of the Belfast Maritime Consortium Strength in Places project, 'Decarbonisation of Maritime Transportation: A return to Commercial Sailing' project. Three research areas were considered including modelling and accessing impact damage in composites marine structures, hybrid composite-metal laminates for bolted joints, and application of artificial intelligence in the failure prediction of composite materials.

In the first study, a detailed comparative numerical study was conducted using high fidelity finite element analysis to compare the low velocity impact (LVI) and compression-after-impact (CAI) performance of conventional legacy quad laminates (LQL) and alternative 'Double-Double' (DD) laminates. An in-house intralaminar damage model, capturing both fibre-dominated and matrix-dominated damage, along with an available interlaminar cohesive model were used within an explicit dynamic formulation. The LQL results were validated using available experimental data before modelling the corresponding DD laminates. In addition, the LVI and CAI response of 3D woven layer-to-layer composites have been modelled. In the case of 3D woven composites, the associated compaction with the manufacturing process was also modelled before the LVI and CAI step.

In the second study, modified transverse cack tensile (mTCT) setup was extended for calculation of mode II fracture toughness in the case of composite-metal laminates. A preliminary parametric study was conducted using finite element analysis to determine the design parameters. Mechanical tests and digital image corelation (DIC) technique were then used to show that the proposed test setup can be extended to composite-metal laminates. In the third study, data-driven probability embedded failure criterion was 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) finite element models were used for the generation of failure points.

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

MECHANICAL PROPERTIES AND THERMAL INSULATION IN POLYMER COMPOSITES USING COCONUT AS PHASE CHANGE MATERIAL

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Phase change materials (PCM) are those materials which change their state from one to another i.e., from solid to liquid or from liquid to solid. The associated energy with these transitions is called latent heat. A fabric containing a PCM can act as a transient thermal barrier which regulates the heat flux. Polymer composites containing PCMs behave as an insulating material. In this work, coconut oil has been used as a PCM in the polymer composite to optimize the concentration of phase change material relating to the thickness of the composite. Composites were developed by the stacking of different nonwoven layers of polyester fibers and polyester resin. It is studied how PCM effects in gaining thermal insulation with low thickness. Composites have been developed with different thicknesses as well as different PCM concentrations. The tests of tensile, flexural and hardness properties as well as thermal insulation properties were conducted. It is found that tensile strength decreases as the thickness of the composite increases. Also, it is found that the flexural strength and hardness of the composites increases with the increase of the thickness. Moreover, it is established that the addition of PCMs in the composites enhances the insulation property of the composites and it is possible to attain the same insulation with lower thickness with added PCMs than the composites with higher thickness without the PCMs.

Keywords: Phase change materials, polyester resin, insulation

INVESTIGATING THE EFFECT OF NANOFILLERS ON PIEZORESPONSE OF POLY (VINYLIDENE FLUORIDE) COATED KNITTED FABRICS

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It is essential to monitor the health indicators regularly to lead a healthy life. This can be achieved by incorporating the flexible sensing devices into textiles. Here, textile based flexible substrates coated with piezoelectric materials have been prepared to capture the signals produced as a response of biomotions. Polyvinylidene fluoride (PVDF), a promising piezoelectric polymer material has been mixed with various concentrations of BaTiO3/graphene and deposited on knitted polyester fabrics. The coated fabric has been characterized through FTIR and XRD to investigate the β-phase of PVDF. The surface morphology and thermal behaviour were observed by SEM and DSC analysis, respectively. The incorporation of BaTiO3 into polyvinylidene fluoride increases the electroactive β-phase that leads to higher voltage and current. The higher signal to noise ratio makes the device more sensitive and reliable. The device has been integrated into textile garments to capture the signals from movement of figure, knee and elbow. The clear signal can be observed as a response of movement of body organs. The observations establish the potential application of the devices in sensing of biomotions.

Keywords: coating, graphene, knitted fabrics, piezoelectric, sensing

ANALYSING THE MECHANICAL BEHAVIOUR OF UNIDIRECTIONAL AND WOVEN THERMOSET COMPOSITES

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Composite materials are emerging as a preferred and viable solution for a wide range of weight-critical applications such as aerospace, automotive and sports owing to their lightweight and high stiffness-to-weight ratio. However, composite materials can create pollution in the environment which can be minimized by the usage of natural fibres as reinforcement. Natural fibre-reinforced thermoset composites can provide better properties i.e., specific strength with minimal cost as well as biodegradation. In this research work, jute yarn is used as reinforcement in unidirectional and woven forms. The composite laminates were developed by hand layup technique using unsaturated polyester resin. The fabricated laminates were mechanically assessed in terms of the tensile and bending test. The unidirectional thermoset composites have depicted better tensile properties compared to woven composites due to fewer undulations in yarn and more fibres in the direction of the force. However, woven composites have shown better bending characteristics compared to unidirectional composites.

Keywords: Natural fibre, thermoset composites, hand layup, mechanical properties.

ELECTROSPINNING PROCESS OPTIMISATION OF CHITOSAN NANOFIBRES PRODUCTION

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Chitosan is an important biomaterial due to its various application in filtration, wound dressings, tissue engineering and as a natural antimicrobial agent. Therefore, the electrospinning process optimisation was carried out with the aim to produce chitosan nanofibres with maximum chitosan concentration. Polyethylene oxide was used as a co-spinning agent and glacial acetic acid was used as a solvent during electrospinning. Surface morphology and fibre diameter analysis were carried out by using scanning electron microscopy (SEM). Results illustrated that smooth nanofibre production was achieved from solutions with 1% to 3.5% chitosan. However, when the concentration of chitosan was 4% or above, nanofibres production was not achieved due to high viscosity and high surface tension of the spinning solution. Furthermore, fibre diameter analysis illustrated that higher applied voltage and longer working distance resulted in finer nanofibres production.

Keywords: Chitosan, filtration, electrospinning, concentration, fibre diameter, nanofibres

AN ANALYSIS OF THE MECHANICAL BEHAVIOR OF 3D WOVEN WARPS, WEFTS, AND BIDIRECTIONAL INTERLOCK STRUCTURES AS REINFORCEMENT FOR IMPACT APPLICATIONS

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Nowadays, auxetic structures are under great interest in scientific research due to their exceptional mechanical properties. In the current study, three different types of 3D orthogonal auxetic woven structures namely warp, weft, and bidirectional interlock were developed. The effect of interlocking patterns on the auxeticity and mechanical performance of the structure was studied. A comparison was established between warp, weft, and bidirectional interlock structures in terms of auxeticity, tensile strength, stiffness, and tear strength. The results showed that the 3D woven warp interlock structure showed maximum auxeticity, while the bidirectional interlock structure showed minimum auxeticity. Due to higher auxeticity, the thickness of the warp interlock structure was increased after applying force to it. Change in the thickness of the woven structure increased its energy dissipation capability, therefore the structure having higher auxeticity also showed higher mechanical performance as compared to the other structures. The tensile strength of a 3D woven warp interlock structure warp-wise is 30.60 % higher as compared to 3D woven weft interlock structure warp-wise. The tear strength of the 3D woven warp interlock structure warp-wise is 17.64% higher as compared to 3D woven bidirectional structure. The stiffness results of 3D woven warp interlock structure warp-wise are 128.75% higher as compared to 3D woven weft interlock structure warp-wise. The results are also statistically analyzed with the help of One-way ANOVA (Tukey), which showed that auxeticity has a significant effect on the tensile strength, fabric stiffness, and tear strength results.

Keywords: 3D woven structure, Auxetic structures, protective textiles, higher performance fabrics, Auxetic fabrics

FABRICATION OF HYBRID COMPOSITE STRUCTURES BY USING FUNCTIONALIZED GRAPHENE NANOPARTICLES FOR AUTOMOTIVE INDUSTRY

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In this study, properties of graphene-functionalized PEG, VAc, and hybrid nanoparticle-based composites were investigated. This research was conducted to increase interlaminar shear strength and mechanical properties of Composites. Composites were fabricated with the incorporation of 0.5% of functionalized nanoparticles by using hand layup technique and different characterization like FTIR, and mechanical tests (Tensile, Charpy, Izod, and Thermal mechanical analyzer) were performed. Results of Impact, thermal and tensile shows significant improvement in toughness, stiffness and in thermal stability of functionalized based hybrid composites. The strength of hybrid is 5-8% higher than simple composite as it was the combination of both PEG and VAc. Gr/PEG shows the lowest mechanical results because the concentration used in composite was very small. It shows the highest strength at more than 10% concentration.

Keywords: Graphene, Epoxy, Glass fabric reinforcement, Polyethylene glycol, Vinyl acetate, ILSS

DEVELOPMENT AND CHARACTERIZATION OF MULTIFUNCTIONAL CARBON FABRIC-REINFORCED POLYMER COMPOSITES INCORPORATED WITH INORGANIC FLAME RETARDANTS

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Carbon fabric-reinforced polymer (CFRP) composites were incorporated with novel, environment-friendly and low-cost inorganic flame-retardant (FR) materials. Synergistic properties of potash alum (KA) and magnesium hydroxide (MH) were obtained by infusing these materials in the carbon woven fabric with diglycidial ether of bisphenol-A epoxy (EP) matrix through resin infusion technology. Composite samples EP80%MH20% and EP80%MH15%KA5% showed Underwriter Laboratories 94 (UL94) V-2 rating, EP80%MH10%KA10% and EP80%MH5%KA15% showed UL94 V-1 rating, and EP80%KA20% showed UL94 V-0 rating. Flame retardancy of EP was improved with increasing concentration of KA up to UL94 V-0 while a high concentration of MH improved flame retardancy only up to UL94 V-2 rating, which is not suitable for the material. Flexural modulus and flexural strength of EP were decreased with increasing concentration of KA and MH because both FR created the distance between the EP chains and hence imparted ductility. Thermogravimetric analysis showed an increase in char residue with increasing KA concentration. The char residue of EP100% (without FR materials) was 16.5 wt %, which increased to 71.2 wt% for EP80%KA20%. CFR samples were prepared with the given FR materials, and it was seen that reduction in mechanical properties was compensated with the help of CFRP.

Keywords: Carbon fabric reinforcement, DGEB-A epoxy composite, flame retardant, in-plane shear properties, UL94

FLEXURAL PERFORMANCE OF THREE-DIMENSIONAL BRAIDED COMPOSITE JOINTS

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Three-dimensional braided carbon fiber reinforced epoxy composites have been widely used in transport and aerospace industries owing their excellent impact properties, delamination resistance and high strength-to-weight ratio. To make a complex product, joining operation is mandatory to assemble the smaller individual parts. Bolted joints are generally used for this purpose due to their operations simplicity, the lower-cost tooling, and scrutiny requirements. Minor loads eccentricity induces secondary bending in composite joints, which is a serious concern. In this study flexural performance of 3D braided bolted joints with different braiding angles and hole diameters has been investigated. It provides a complete insight for design and application of 3-D braided open hole composite, which can retain the structural performance rather than possibly compromising the whole system. Three-point bending test was conducted which presents that initially the damage occurs in the top surface of 3D braided open hole composite. Braiding angle effects, the failure modes. With increase in braiding angle the failure mode gradually changed from fiber breakage to interface debonding. Strength reduction of composite caused by drilling operation also decreased with increase in braiding angle. The strength reduction of 3D braided open hole composite with hole diameter of 1.5 is 13.8% and 5.8% for 10° and 30° braiding angle. A fast decline in the flexural strength occurred with increase in hole diameter.

Keywords: 3D braided composite, Flexural performance, Bolted joint, Open hole

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