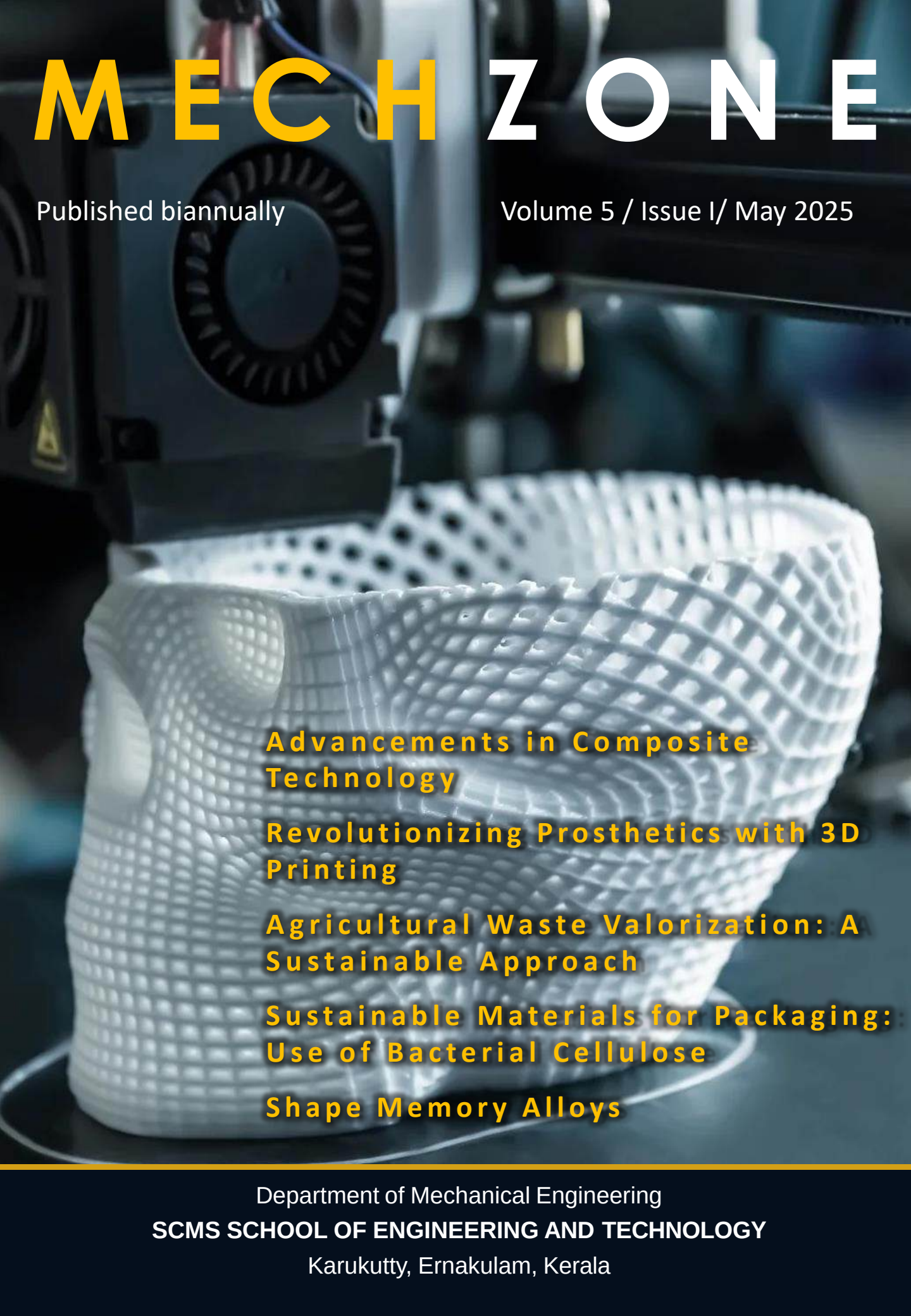


MECHZONE



Published biannually

Volume 5 / Issue I/ May 2025

Advancements in Composite Technology

Revolutionizing Prosthetics with 3D Printing

Agricultural Waste Valorization: A Sustainable Approach

Sustainable Materials for Packaging: Use of Bacterial Cellulose

Shape Memory Alloys

Department of Mechanical Engineering
SCMS SCHOOL OF ENGINEERING AND TECHNOLOGY
Karukutty, Ernakulam, Kerala



MESSAGE FROM THE HEAD OF THE DEPARTMENT

On behalf of the faculty and students of the Mechanical Engineering Department, I extend a warm welcome to the latest edition of MECHZONE. It is heartening to witness the enthusiasm and dedication of our students and faculty in bringing out this technical magazine, despite their demanding academic schedules. Our department continues to make great strides, offering various Addon courses and fostering an environment of learning beyond the classroom. While we take pride in our placement achievements, we aim to see more students securing positions in core mechanical industries. In this regard, I would like to emphasize the importance of the Graduate Aptitude Test in Engineering (GATE). This nationwide examination evaluates a candidate's grasp of fundamental engineering concepts and plays a crucial role in postgraduate admissions at premier institutions like the IITs and IISc. Notably, universities abroad, such as the National University of Singapore, now consider GATE scores for MS and Ph.D. admissions. Moreover, Public Sector Units (PSUs) like ONGC, BPCL, Indian Oil, HPCL, and NTPC recruit mechanical engineers based on their GATE performance, offering prestigious and well-paying career opportunities. Students aspiring for a career in core industries should start preparing for GATE from their second year, as the topics covered in the exam align with the curriculum of the second and third years of undergraduate study. Beyond theoretical knowledge, success in GATE requires a strong ability to apply engineering principles to solve real-world problems. Regular practice through mock tests and sample papers will significantly enhance one's chances of securing a high score. I encourage all students to set their sights high, prepare diligently, and make the most of the opportunities ahead. I am confident that in the coming years, we will witness more students from our department excelling in securing placements in top engineering firms and PSUs. Wishing you all success in your academic and professional journeys!

Dr. Vidya Chandran

Head of the Department
Mechanical Engineering



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Vision and Mission

Vision and Mission of the Institute

Vision

1. To be a premier institution moulding ethical and socially responsible engineers with emphasis on 'Service Learning'.
2. To be among the top ten institutions in India by 2040, shaping technology innovators and leaders for spearheading research relating to sustainable development goals

Mission

Innovative education and research for shaping techno-leaders.

Vision and Mission of the Department

Vision

To be a leader in Mechanical Engineering education through sustainable innovation and impactful research.

Mission

1. Integrate service-learning into Mechanical Engineering education to solve local and global challenges.
2. Upskill students in emerging technologies to lead design, manufacturing, and allied industrial sectors.
3. Promote innovative and interdisciplinary research in Mechanical Engineering, emphasizing sustainable and ethical practices

Advancements in Composite Technology

by Dr. Raghav G R

Composite materials have revolutionized industries ranging from aerospace and automotive to construction and renewable energy. By combining two or more distinct materials, composites offer superior mechanical properties, lightweight characteristics, and enhanced durability compared to traditional materials. Recent advancements in composite technology have focused on improving manufacturing techniques, developing sustainable materials, and integrating smart functionalities. This article explores the latest innovations in composite materials, their applications, and future trends.

Advanced Manufacturing Techniques

Automated Fiber Placement (AFP) and Automated Tape Laying (ATL)

Automated manufacturing techniques such as AFP and ATL have significantly enhanced the precision and efficiency of composite production. These methods use robotic systems to lay down carbon fiber tapes or tows in precise orientations, optimizing strength-to-weight ratios. Companies like Boeing and Airbus utilize AFP to manufacture large-scale aircraft components with reduced waste and faster production times.



Automated fiber placement technique

3D Printing of Composites

Additive manufacturing has expanded into composite materials, enabling the production of complex geometries that were previously unattainable. Continuous fiber-reinforced 3D printing allows for the embedding of carbon, glass, or Kevlar fibers within thermoplastic matrices. Companies like Markforged and Arevo have developed printers capable of producing high-strength composite parts for aerospace, automotive, and medical applications.

Out-of-Autoclave (OoA) Processes

Traditional autoclave curing is energy-intensive and costly. Recent developments in OoA techniques, such as vacuum-assisted resin transfer molding (VARTM) and microwave curing, reduce production time and energy consumption while maintaining high-quality composite structures.

Sustainable and Eco-Friendly Composites

Bio-Based and Natural Fiber Composites

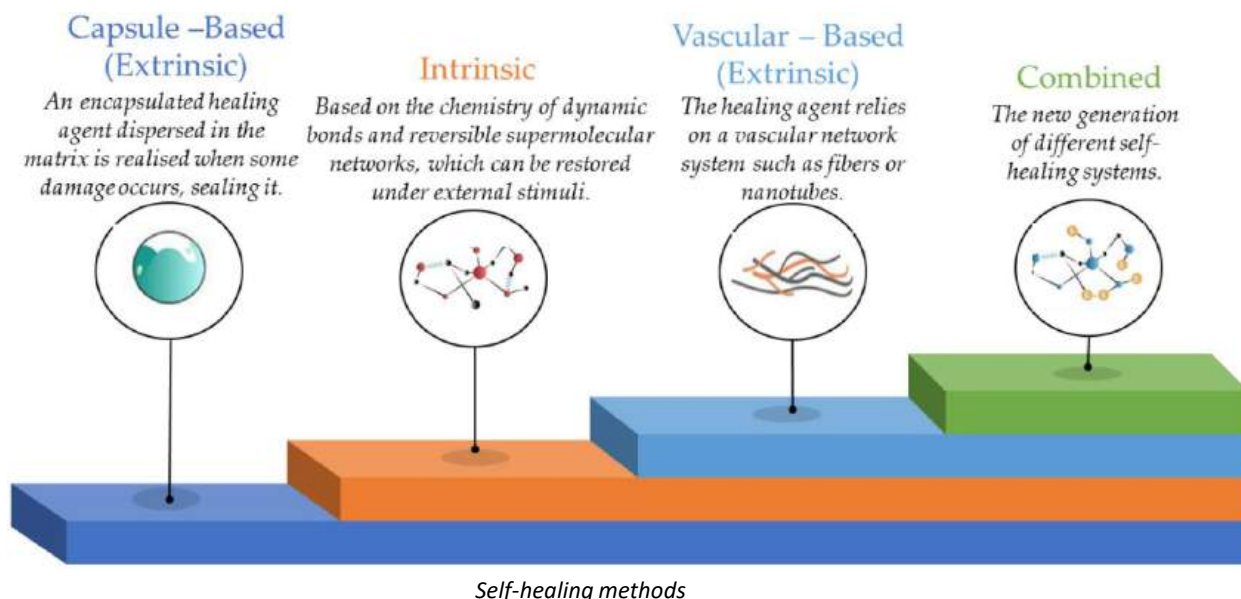
Growing environmental concerns have driven research into sustainable alternatives to synthetic fibers. Natural fibers such as flax, hemp, and bamboo are being used as reinforcements in biodegradable composites. These materials are lightweight, cost-effective, and have a lower carbon footprint. Companies like Bcomp (Amplitex) are developing high-performance natural fiber composites for automotive interiors and sporting goods.

Recyclable Thermoset Composites

Traditional thermoset composites are difficult to recycle due to their cross-linked polymer structures. However, breakthroughs in vitrimer resins—a new class of polymers that can be reshaped and recycled—are paving the way for sustainable thermoset composites. Researchers at MIT and other institutions have developed vitrimer-based composites that retain high performance while being recyclable.

Self-Healing Composites

Inspired by biological systems, self-healing composites incorporate microcapsules or vascular networks that release healing agents when damage occurs. These materials extend the lifespan of composite structures in aerospace and wind turbine blades, reducing maintenance costs. Recent studies have explored graphene-enhanced self-healing mechanisms for improved conductivity and structural repair.



Smart and Multifunctional Composites

Structural Health Monitoring (SHM)

Integrating sensors into composite materials enables real-time monitoring of structural integrity. Fiber optic sensors, piezoelectric materials, and carbon nanotube networks can detect strain, temperature, and damage. Airbus and NASA are implementing SHM systems in aircraft wings to predict failures and improve safety.

Energy-Harvesting Composites

Researchers are developing composites that can generate and store energy. Piezoelectric composites convert mechanical vibrations into electricity, while graphene-enhanced supercapacitors embedded in composites offer energy storage capabilities. These innovations are particularly useful in wearable technology and IoT-enabled infrastructure.

Shape Memory Composites

Self-healing materials have emerged as a game-changer in composite technology. These materials contain microcapsules filled with healing agents that are released when cracks form, allowing the material to repair itself. This innovation extends the lifespan of composites and reduces maintenance costs, making it ideal for aerospace, construction, and infrastructure applications. Recent research has explored the use of vascular networks and shape-memory polymers to enhance self-healing capabilities further. These advanced techniques ensure continuous repair over multiple damage cycles, improving the reliability and longevity of composite structures.

Future Trends and Challenges

Nanocomposites and Multiscale Reinforcement

The integration of nanomaterials like graphene, carbon nanotubes, and nanocellulose enhances mechanical, thermal, and electrical properties. Multiscale composites, combining micro and nano reinforcements, are expected to dominate next-generation materials for extreme environments.

AI and Machine Learning in Composite Design

Artificial intelligence is optimizing composite material design by predicting optimal fiber orientations, resin formulations, and failure modes. Companies like Ansys and Dassault Systèmes are leveraging AI-driven simulation tools to accelerate composite development.

Challenges in Adoption

Despite advancements, challenges remain, including high production costs, scalability of new manufacturing methods, and standardization of recycling processes. Collaboration between academia, industry, and policymakers is essential to overcome these barriers.

Conclusions

The field of composite technology is rapidly evolving, driven by innovations in manufacturing, sustainability, and smart functionalities. From 3D-printed composites to self-healing and energy-harvesting materials, these advancements are reshaping industries and enabling next-generation applications. As research continues, the future of composites promises lighter, stronger, and more sustainable solutions for global challenges.

Revolutionizing Prosthetics with 3D Printing

by Mr. Anoob Jose

Introduction

The field of prosthetics has undergone a remarkable transformation in recent years, thanks to the integration of 3D printing technology. Traditional prosthetic limbs were often expensive, heavy, and required extensive customization by skilled artisans. However, additive manufacturing has revolutionized the industry by enabling rapid prototyping, personalized designs, and cost-effective production. Today, 3D-printed prosthetics are not only more accessible but also incorporate advanced materials and smart technologies that enhance functionality and comfort. This article explores the latest developments in 3D-printed prosthetics, focusing on customization, material innovations, smart prosthetics, affordability, and future trends.

Customization and Personalization

One of the most significant advantages of 3D printing in prosthetics is the ability to create highly customized solutions tailored to individual users. Traditional prosthetics often require multiple fittings and adjustments, but 3D scanning and modeling now allow for precise anatomical matching. For instance, companies like Open Bionics use 3D scanning to design their Hero Arm, a lightweight bionic prosthetic that fits perfectly to the user's residual limb. This level of customization reduces discomfort and improves mobility.



Beyond functional fit, 3D printing also enables aesthetic personalization. Prosthetic limbs can now be designed with unique colors, patterns, or even themed appearances, such as superhero-inspired arms for children. Organizations like e-NABLE, a global volunteer network, provide free 3D-printable prosthetic designs, allowing users to choose styles that reflect their personalities. This personalization not only enhances comfort but also helps users feel more confident and empowered.

Advanced Materials for Durability and Comfort

The materials used in 3D-printed prosthetics have evolved significantly, offering better durability, flexibility, and comfort. Lightweight polymers like nylon and thermoplastic polyurethane (TPU) are commonly used because they provide strength without adding excessive weight. Carbon fiber-reinforced composites are also gaining popularity for their high strength-to-weight ratio, making them ideal for load-bearing prosthetic components.

Another exciting development is the integration of soft robotics and silicone in prosthetic design. Researchers at MIT have developed 3D-printed prosthetic hands with pneumatic actuators that mimic natural movement, while other projects incorporate silicone padding for improved grip and comfort. These advancements ensure that prosthetics are not only functional but also comfortable for long-term wear.



Smart and AI-Enhanced Prosthetics

The integration of smart technologies has taken 3D-printed prosthetics to the next level. Myoelectric prosthetics, which use electromyography (EMG) sensors to detect muscle signals, allow users to control their prosthetic limbs with intuitive movements. Open Bionics' Hero Arm, for example, employs machine learning to improve gesture recognition over time, making the prosthetic more responsive with continued use.

Haptic feedback is another groundbreaking innovation. Researchers at ETH Zurich have developed a 3D-printed prosthetic hand equipped with pressure and temperature sensors that provide real-time tactile feedback. This allows users to "feel" objects, enhancing their ability to perform delicate tasks. Such advancements blur the line between artificial and natural limbs, offering users a more seamless experience.

Cost Reduction and Accessibility

One of the most impactful benefits of 3D-printed prosthetics is their affordability. Traditional prosthetic limbs can cost anywhere from 5,000 to 50,000, making them inaccessible to many people, especially in developing countries. In contrast, 3D-printed prosthetics can be produced for as little as 50 to 500, drastically reducing costs. This is particularly beneficial for children, who often outgrow their prosthetics and require frequent replacements.

Open-source initiatives have further democratized access to prosthetic technology. Platforms like Thingiverse and e-NABLE provide free, downloadable 3D-printable prosthetic designs, enabling local communities, schools, and even individuals to manufacture prosthetics at a fraction of the cost. These efforts have made life-changing technology accessible to people who would otherwise go without.

Future Trends

The future of 3D-printed prosthetics is filled with exciting possibilities. One promising area is bioprinting, where researchers are exploring the use of 3D-printed scaffolds infused with living cells to create bio-integrated prosthetics. The Wake Forest Institute, for instance, is working on 3D-printed skin and muscle grafts that could improve prosthetic attachment and functionality.

Artificial intelligence is also expected to play a larger role in prosthetic development. AI-powered prosthetics could learn and adapt to users' movement patterns, offering even greater precision and ease of use. Additionally, the rise of on-demand 3D printing clinics in hospitals could enable same-day prosthetic production, eliminating long waiting periods and improving patient outcomes.

Conclusions

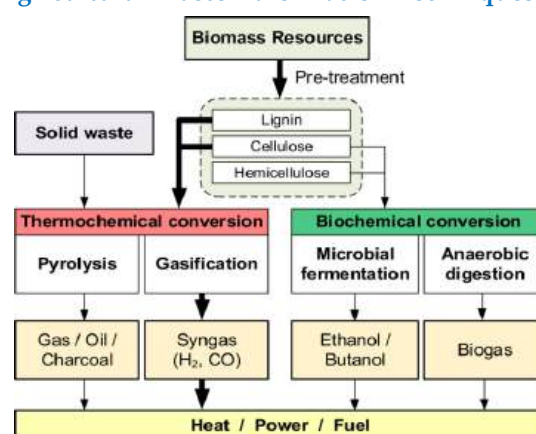
3D printing has revolutionized the prosthetics industry by making devices more customizable, affordable, and technologically advanced. From personalized designs and advanced materials to smart prosthetics with AI and haptic feedback, the possibilities are expanding rapidly. As research continues and technology advances, 3D-printed prosthetics will become even more lifelike, accessible, and integrated with the human body. These innovations promise to improve the quality of life for millions of people worldwide, offering them greater independence and mobility than ever before.

Agricultural Waste Valorization: A Sustainable Approach

by Aghil Krishna Mangalappilly U , Anson Varghese , Akin P Kennedy , Vivek V (S8 ME, Batch 21)

Agricultural waste, including crop residues, fruit peels, seed husks, livestock manure, and food processing by-products, constitutes a major fraction of global organic waste. Historically, such waste has been discarded, incinerated, or left to decompose, leading to environmental issues such as air pollution, water contamination, and soil degradation. However, advancements in waste management technologies have demonstrated that agricultural residues possess significant potential for resource recovery and sustainable applications. Instead of being treated as a disposal problem, agricultural waste can be processed into biofuels, biodegradable materials, fertilizers, and high-value chemicals, aligning with the principles of a circular economy. Integrating agricultural waste into industrial production cycles can reduce reliance on non-renewable resources while addressing waste accumulation issues. For instance, biopolymers derived from fruit peels offer eco-friendly alternatives to plastic packaging, while crop residues can be processed into biochar for soil improvement. Additionally, nanomaterials extracted from plant-based waste have been explored for applications in medicine, energy storage, and advanced material development. Research indicates that utilizing agricultural waste can reduce environmental impact, lower production costs, and enhance energy security, making it an attractive solution for sustainable development. This review aims to explore various waste valorization techniques, comparing their environmental and economic impacts. By examining studies on biomass conversion, biodegradable materials, nanotechnology, and soil amendments, this paper provides insights into emerging innovations, challenges, and future research needs. The findings will contribute to the broader discussion on how agricultural waste can be effectively managed to promote sustainability, industrial innovation, and resource efficiency.

Agricultural Waste Valorization Techniques



Biomass Conversion for Energy

The conversion of agricultural biomass into renewable energy sources is one of the most extensively studied valorization techniques. Pyrolysis, a thermal decomposition process conducted under an oxygen-free environment, enables the transformation of lignin- and protein-rich biomass into bio-oil, biochar, and syngas. However, bio-oil derived from traditional pyrolysis methods often suffers from high oxygen content, instability, and low calorific value. To address these limitations, researchers are exploring catalytic pyrolysis and hydrodeoxygenation techniques, which improve fuel quality and enhance energy efficiency.

Biopolymer Production and Sustainable Packaging

As concerns about plastic pollution and non-biodegradable waste escalate, researchers are actively exploring biopolymer production from agricultural residues as a sustainable alternative. Nanocellulose-based superabsorbent hydrogels (SAHs) extracted from rice straw, wheat straw, and sugarcane bagasse demonstrate remarkable water retention, mechanical stability, and biodegradability, making them ideal for agriculture, medicine, and food packaging. These hydrogels have been shown to enhance soil moisture retention, reduce irrigation needs, and support plant growth in drought-prone regions.

Another innovative approach involves starch-based barrier coatings, which provide moisture resistance, grease repellency, and enhanced durability in food packaging applications. Starch-based biopolymers offer a viable alternative to synthetic plastic coatings, particularly in food packaging, pharmaceuticals, and electronics wrapping. However, scalability, cost-effectiveness, and mechanical strength limitations remain key challenges for commercial adoption. Advanced modification techniques such as cross-linking, reinforcement with nanomaterials, and blending with other biopolymers are being explored to improve the functional properties of these materials.

The market for biodegradable packaging is expanding rapidly due to increasing consumer awareness and stringent environmental regulations against single-use plastics. Nevertheless, standardized production methods, cost reduction strategies, and improved supply chain infrastructure are required for large-scale commercialization. Future research should focus on enhancing polymer durability, optimizing processing techniques, and developing hybrid biopolymer composites to accelerate the transition toward sustainable packaging solutions.

Biochar and Soil Amendments

Biochar, a carbon-rich material derived from agricultural waste, has gained significant attention due to its potential to improve soil fertility, carbon sequestration, and plant productivity. Produced through pyrolysis, biochar helps increase soil organic carbon (SOC) levels, enhance microbial activity, and improve water retention capacity. These benefits make biochar particularly valuable in nutrient-poor or degraded soils, where it can boost crop yields and promote sustainable farming practices. Additionally, biochar acts as a soil amendment by reducing heavy metal toxicity and minimizing nutrient leaching, thus improving overall soil health.

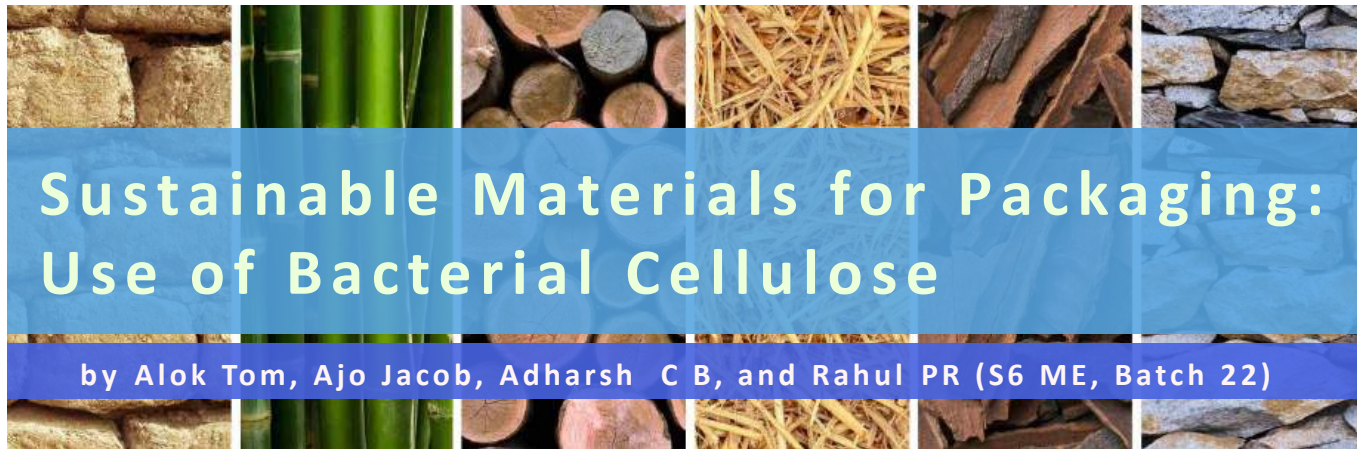
Some studies have reported nitrogen immobilization when biochar is applied in excess, leading to temporary nutrient deficiencies. To address this issue, researchers are exploring biochar-enriched composts and microbial inoculation techniques to enhance nutrient availability. While biochar has promising applications, economic and logistical barriers hinder its widespread use. The high cost of production, lack of standardized quality control measures, and limited farmer awareness present challenges for large-scale adoption.

Nanomaterials from Agricultural Waste

Nanotechnology has revolutionized material science, and recent research has demonstrated that agricultural waste-derived nanomaterials offer diverse applications in medicine, energy, packaging, and water purification. Nanocellulose extracted from plant fibers exhibits high tensile strength, biocompatibility, and biodegradability, making it an excellent candidate for drug delivery systems, wound dressings, and food packaging films. Additionally, nanosilica synthesized from rice husks is used in concrete reinforcement, biomedical coatings, and high-performance ceramics. Despite these promising applications, challenges such as high production costs, variability in feedstock composition, and environmental concerns related to nanoparticle disposal must be addressed. Ongoing research is focused on developing scalable, low-cost synthesis techniques, optimizing nanoparticle stability, and improving their environmental safety. Future innovations could pave the way for biodegradable, plant-based nanomaterials that replace synthetic polymers in biomedical and industrial applications.

Conclusion

Agricultural waste valorization presents a transformative opportunity for addressing environmental pollution, energy scarcity, and resource depletion. This review highlights the diverse applications of biofuels, bioplastics, nanomaterials, and soil amendments, demonstrating the potential of agricultural residues in sustainable industries. By integrating scientific research, industry innovations, and policy support, agricultural waste can be transformed into valuable resources, contributing to a greener and more sustainable future.



Sustainable Materials for Packaging: Use of Bacterial Cellulose

by Alok Tom, Ajo Jacob, Adharsh C B, and Rahul PR (S6 ME, Batch 22)

The increasing environmental concerns associated with plastic waste have led to an urgent search for sustainable alternatives in packaging. Traditional plastic materials, derived from fossil fuels, pose serious ecological challenges, including long degradation periods, microplastic pollution, and the emission of greenhouse gases during production and disposal. Biodegradable and renewable packaging materials are now at the forefront of scientific research and industrial innovation, with bacterial cellulose emerging as a promising alternative.

Bacterial cellulose (BC) is an organic biopolymer synthesized by certain strains of bacteria, such as *Komagataeibacter xylinus*. Unlike plant-derived cellulose, bacterial cellulose possesses a highly pure, crystalline nanofibrillar structure that endows it with exceptional mechanical strength, flexibility, and biodegradability. Due to its superior material properties and its ability to be sustainably produced through fermentation, bacterial cellulose has gained considerable interest in the packaging industry. This article explores the unique attributes of bacterial cellulose, its advantages over traditional materials, and its potential applications in sustainable packaging solutions.



Edible transparent packing material made of Bacterial Cellulose

What is Bacterial Cellulose?

Bacterial cellulose is an organic polymer synthesized by various bacterial species, including *Komagataeibacter xylinus* and *Acetobacter* spp. Unlike plant-derived cellulose, BC is produced extracellularly as a highly pure and nanofibrillar network. This biofabrication process results in a material that possesses excellent mechanical strength, high water-holding capacity, and superior biodegradability. Additionally, BC can be tailored through genetic and biochemical modifications to enhance its physical and functional properties for specific packaging applications.

Advantages of Bacterial Cellulose for Packaging

Biodegradability and Environmental Sustainability

One of the most significant advantages of bacterial cellulose is its complete biodegradability. Unlike synthetic plastics, which persist in the environment for centuries, BC naturally decomposes within a few weeks under microbial action, reducing landfill waste and marine pollution. Furthermore, BC production does not rely on deforestation or fossil fuels, making it an eco-friendly alternative.

Mechanical Strength and Durability

Despite being lightweight, BC exhibits remarkable tensile strength and flexibility, making it suitable for protective packaging applications. The nanofibrillar structure of BC provides a high surface area, contributing to its durability and resistance to mechanical stress. This property allows BC to be used in flexible films and rigid packaging solutions.

Barrier Properties

Bacterial cellulose demonstrates excellent gas barrier properties, particularly for oxygen and moisture. This characteristic is crucial for food packaging, as it helps extend the shelf life of perishable products by preventing oxidation and microbial contamination. Additionally, BC can be modified with hydrophobic coatings to enhance its water resistance.

Customizability and Functionalization

Through chemical and genetic modifications, bacterial cellulose can be infused with antimicrobial agents, antioxidants, or biocompatible coatings to improve its functionality. This feature makes BC an ideal candidate for smart packaging solutions, where active materials interact with packaged goods to enhance preservation and quality control.

Applications in Packaging

Bacterial cellulose has shown great potential in multiple areas of sustainable packaging.

Food Packaging

Given its non-toxic nature, high purity, and biodegradability, BC is an excellent candidate for food packaging. It can be used to wrap perishable goods, extend shelf life, and prevent microbial contamination when combined with natural antimicrobial agents.

Flexible Packaging Films

BC-based films can replace conventional plastic films used in snack packaging, wrapping materials, and single-use containers. Hybrid formulations combining BC with biopolymers such as starch or chitosan can enhance performance.

Paper and Carton Coatings

BC can be applied as a coating material to paper-based packaging to improve water resistance and durability without compromising recyclability.

Smart and Active Packaging

The integration of bacterial cellulose with biosensors or bioactive compounds can enable intelligent packaging that monitors freshness, detects contamination, or releases preservatives to extend product lifespan.

Challenges and Future Prospects

Despite its promising attributes, several challenges must be addressed for the large-scale adoption of bacterial cellulose in packaging. These include the high production cost, scalability limitations, and the need for further research into optimizing material properties for diverse applications. Advances in biotechnological production methods, genetic engineering of cellulose-producing bacteria, and cost-effective fermentation processes could pave the way for more affordable and accessible BC-based packaging solutions. With increasing regulatory restrictions on plastic usage and rising consumer demand for sustainable alternatives, bacterial cellulose has the potential to revolutionize the packaging industry. Continued research and industry collaboration will be crucial in overcoming production challenges and establishing bacterial cellulose as a mainstream eco-friendly packaging material.

Conclusion

Bacterial cellulose represents a highly promising and sustainable alternative to conventional packaging materials. Its biodegradability, strength, and adaptability make it an attractive choice for various applications, particularly in food and flexible packaging. While current challenges related to cost and scalability remain, ongoing advancements in bioprocessing and material engineering hold great potential for making bacterial cellulose a commercially viable solution. As industries and consumers move towards greener choices, bacterial cellulose is poised to play a key role in the future of sustainable packaging.

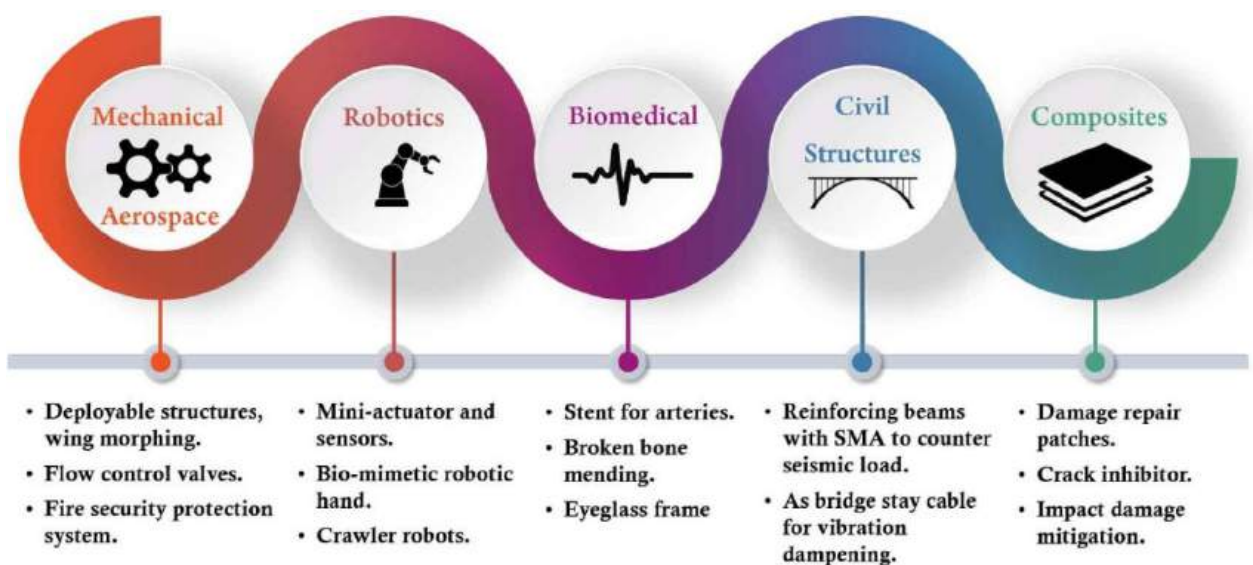
Shape Memory Alloys

by Abhiram V U, Adarsh Suresh, Adithyan Ajith, Jerin Shaju (S2 ME)

Shape Memory Alloys (SMAs) are a class of metallic materials that possess the unique ability to return to their original shape when subjected to specific temperature changes. This remarkable property is due to a reversible phase transformation between two different crystal structures: martensite (low temperature) and austenite (high temperature). When an SMA is deformed in its martensitic phase and then heated beyond a critical temperature, it reverts to its pre-deformed shape as it transforms into the austenitic phase. This ability to “remember” its shape has made SMAs highly valuable in industries such as aerospace, medicine, robotics, and automotive engineering.

Working Mechanism of SMAs

The functionality of SMAs is based on a reversible phase transformation between martensitic and austenitic structures. At lower temperatures, the material exists in the martensitic phase, which is highly deformable due to its less ordered atomic arrangement. When heated above the transformation temperature, the SMA transitions into the austenitic phase, which has a more stable and symmetrical crystal structure. This transition allows the material to recover its original shape, giving rise to the shape memory effect. The temperature range at which this transformation occurs is a critical factor and is precisely controlled for different applications.



Applications of Shape Memory Alloys

Types of Shape Memory Alloys

The most commonly used SMAs are based on nickel-titanium (NiTi), copper, and iron alloys:

Nickel-Titanium (NiTi) Alloys (Nitinol): These are the most widely used SMAs due to their excellent shape memory properties, high corrosion resistance, and biocompatibility. They are extensively used in medical applications such as stents, orthodontic wires, and surgical instruments.

Copper-Based SMAs: Alloys such as Cu-Zn-Al and Cu-Al-Ni offer a lower-cost alternative to NiTi alloys. Although they provide good shape memory properties, they have lower fatigue resistance, which can limit their applications.

Iron-Based SMAs: These alloys, though less common, are used in applications requiring higher transformation temperatures and improved mechanical stability, such as industrial actuators and aerospace components.

Applications of Shape Memory Alloys

SMAs are widely used in various industries due to their unique properties:

Medical Field: SMAs are extensively used in medical devices such as stents, orthopedic implants, and orthodontic wires. Stents made from NiTi alloys can expand within blood vessels when exposed to body temperature, making them ideal for minimally invasive procedures. Orthodontic wires made from SMAs provide continuous force, reducing the need for frequent adjustments.

Aerospace Industry: SMAs are used in actuators for aircraft wing surfaces, where they enable shape-changing components to improve aerodynamic efficiency. They are also employed in deployable structures for space applications, where lightweight, energy-efficient materials are crucial.

Robotics and Automation: SMAs serve as compact and flexible actuators that mimic natural muscle movements, making them useful in biomedical devices, robotic arms, and micro-actuators.

Automotive Industry: SMAs are used in self-adjusting mirrors, seat belt tensioners, and climate control systems that operate without external power sources.



Nichrome



Inconel



Incoloy



Stellite

Advantages of SMAs

SMAs offer several advantages that make them suitable for advanced engineering applications:

Energy Efficiency: They can function without an external power source, making them ideal for passive systems.

High Strength-to-Weight Ratio: Their lightweight yet strong nature makes them suitable for aerospace and medical applications.

Corrosion Resistance: NiTi alloys, in particular, exhibit excellent resistance to corrosion, making them ideal for long-term medical implants.

Biocompatibility: NiTi-based SMAs are widely used in medical applications due to their compatibility with the human body.

ACTIVITIES AT THE DEPARTMENT



Students of S8 ME presented their project on sustainable materials to Mr Roji John, MLA at Karukutty Grama Panchayath.



Students of S8 ME displayed their final-year projects on 'Project Expo' Presented at SSET Campus.



Students of S8 ME (Batch 2021) Visited 'Vajra Rubber Products (P) Ltd', Konathukunnu, Kerala as part of their curriculum enrichment.

ACTIVITIES AT THE DEPARTMENT



Students of S6 ME (Batch 2022) and S4 ME (Batch 2023) Visited 'He-Man Auto Robopark Pvt. Ltd.', Mookkannoor, Kerala, as part of their curriculum enrichment.



Department team at NIPMR with Mr. Chandrababu C, Executive Director NIPMR, Prof. Felicia and Prof. Pingo from Sweden.



Participants of the Addon course 'Introduction to Nanotechnology' organized by the department along with Dr. Jayan Thomas, Full-Bright Fellow, Professor of Nanotechnology and optics, University of Central Florida, USA.

FACULTY ACHIEVEMENTS

- Dr. Raghav G R delivered a talk at the FDP 'Advanced tools and techniques for industrial automation and robotics' Organized by SRM Madurai Institute of Engineering and Technology.
- An article entitled 'Morphological Insights of Carbon nanomaterials using atomic force microscopy and their applications' by Dr. Raghav G R and co-authors published in Surface review and letters.
- An article entitled 'Preparation and Characterization of SiC Particle Enhanced Polyester Fabric/Epoxy Hybrid Composites' by Dr. Gibin George and co-authors published in Polymer Composites.
- Dr. Raghav G R and Dr. Gibin George completed the NPTEL course on Roadmap to Patent creation with Elite Certification.
- Dr. Vidya Chandran and Mr. Jose Sheril D'cotha attended Global Hydrogen and Renewable Energy Summit, at Cochin.



STUDENT'S ACHIEVEMENTS



NATCET Scholarship winners, Mr. Muhammad Rizwan P A and Mr. Abinav J of S8 ME (batch 21)



Winners of Idea Pitching Competition Organized by Association of Energy Engineers.



The student representative and faculty in charge, Mr. Suraj R, received the Best ASME Chapter award of the Kerala section.

STUDENT'S ACHIEVEMENTS

Team 'Paper Boyz' grabbed **First Prize** at **ASME Enginex 2025** - project innovation competition organized by ASME Kerala Section for their project titled "Preparation of Packing Paper from invasive plant species and agricultural waste."



'Paper Boyz' Aghil Krishna U, Vivek V, Akin P Kennady and Annsan Varghese with their project guide Dr. Gibin George.



MECHZONE

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