REVIEW ARTICLE

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Natural Fibre Composites for Sustainable and Lightweight Automotive Materials

Purvi Mistry[1*], Nabo Kumar Barman[2], Dharmendra Bihola[1]

[1]Textile Technology Department, L. D. College of Engineering, Navrangpura, Ahmedabad – 380 015, Gujarat, India

[2]Textile Manufacturing Technology Department, Sir Bhavsinhji Polytechnic Institute, Bhavnagar – 364 001, Gujarat, India

Abstract

Natural fibre composites (NFCs) have gained significant attention as sustainable and lightweight alternatives to traditional automotive materials. Combining renewable plant-based fibres such as flax, hemp, jute, and kenaf with polymer matrices, NFCs offer competitive mechanical properties while reducing environmental impact through lower density, biodegradability, and reduced lifecycle carbon footprint. This paper comprehensively examines the botanical and chemical characteristics of natural fibres, their mechanical and functional properties, and the processing techniques suited for automotive manufacturing. Critical environmental and sustainability aspects, including life cycle assessment and end-of-life options, are analysed. The paper highlights diverse automotive applications, ranging from interior trims to semi-structural components, supported by case studies from Original Equipment Manufacturers (OEMs). The benefits of NFCs, such as weight reduction, acoustic damping, and cost-effectiveness, are weighed against challenges including moisture sensitivity, fibre variability, and thermal processing limitations. Future research directions emphasise advanced fibre treatments, bio-based matrices, hybrid composites, and circular economy integration to overcome current limitations. The synthesis provided underscores NFCs as promising materials enabling the automotive industry's transition toward greener, lighter, and more sustainable vehicles.

Keywords: Natural fibres, composite, Natural fibre composites (NFCs), automotive, mechanical properties

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INTRODUCTION

The automotive industry is undergoing a transformative shift driven by global environmental concerns, stringent regulatory frameworks, and escalating fuel efficiency requirements. In this context, reducing vehicle weight has become a paramount strategy to improve fuel economy, lower greenhouse gas emissions, and enhance overall vehicle performance. Conventional materials such as steel and aluminium, while offering strength and durability, contribute significantly to vehicle mass, thereby limiting the potential for sustainable automotive design. Composites reinforced with synthetic fibres such as glass and carbon have been widely used to achieve lightweighting; however, they pose environmental challenges due to energy-intensive production processes, non-biodegradability, and recycling difficulties.[1–5]

Natural fibre composites (NFCs), which combine renewable natural fibres such as flax, hemp, jute, kenaf, and sisal with polymeric matrices, have emerged as promising sustainable alternatives. These materials offer lower density, comparable specific mechanical properties, and significant reductions in carbon footprint throughout their life cycle compared to synthetic composites.[6–9] The integration of NFCs in automotive components aligns with circular economy principles by promoting resource efficiency and recyclability. Initially implemented in non-structural interior parts, advances in fibre processing and composite manufacturing have expanded NFC applications to semi-structural and structural automotive components. Leading automotive manufacturers, including BMW, Volkswagen, and Volvo, have demonstrated successful use of NFCs in series production, validating their technical viability.[10–12]

Nevertheless, challenges remain for NFCs, including inherent moisture sensitivity, variability of natural fibres, and thermal processing limitations due to fibre degradation

Corresponding Author: Purvi Mistry, Textile Technology Department, L. D. College of Engineering, Navrangpura, Ahmedabad – 380 015, Gujarat, India. e-mail: purvimistry51@gmail.com

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temperatures. Addressing these issues requires optimised fibre treatments, hybrid composites, and bio-based matrix development, which are active areas of research.[13–15] This paper aims to provide a comprehensive overview of natural fibre composites for sustainable and lightweight automotive materials.

Overview of Natural Fibres

Natural fibres, derived primarily from plants, have garnered significant interest as reinforcements for polymer composites used in automotive applications due to their sustainability, abundance, and beneficial mechanical properties. [3,4,16] This section presents an overview of the main categories of natural fibres, their botanical origins, extraction methods, as well as their chemical and physical characteristics that critically influence composite performance.

Classification and Botanical Origins

Natural fibres used in automotive composites are mainly classified into bast fibres, leaf fibres, seed fibres, and others, with bast fibres being the most widely studied and utilised.[4,8,16] Bast fibres are procured from the phloem (inner bark) of plants and include flax (*Linum usitatissimum*), hemp (*Cannabis sativa*), jute (*Corchorus spp.*), kenaf (*Hibiscus cannabinus*), and ramie (*Boehmeria nivea*).[4,16] Leaf fibres, such as sisal (*Agave sisalana*), coir from coconut husks, and abaca, are also employed but generally offer lower mechanical performance than bast fibres. Seed fibres (e.g., cotton) are less commonly used in composites due to their short fibre length and primarily textile applications.

The choice of fibre depends on mechanical requirements, environmental conditions, availability, and economic factors. Bast fibres are favoured in load-bearing and semi-structural automotive applications due to their superior tensile strength and stiffness.

Extraction and Processing Methods

Extraction of natural fibres influences their quality, length, surface properties, and consequently, their performance in composites.[4,16] The predominant method is retting, a biological or chemical process that degrades the pectins that bind the fibres within plant stalks. Different retting methods include water retting, dew retting, and enzymatic retting, each with specific environmental and quality implications.

- Water retting process involves submerging plant stalks in water to allow microbial degradation of binding substances, yielding high-quality long fibres, but with environmental concerns due to water pollution.
- Dew retting process relies on natural drying in the field, producing variable quality fibres but with lower resource use.
- Enzymatic retting process uses controlled enzymes to selectively break down pectins, offering better consistency and environmental benefits.
- Mechanical processes such as decortication physically separate fibres from stalks and often follow retting to improve fibre purity and length.

Chemical Composition

The main components of natural fibres are cellulose (60–75%), hemicellulose (15–25%), lignin (2–15%), pectin, waxes, and cuticles.[4,6,16] Cellulose contributes to high tensile strength due to its crystalline structure, while hemicellulose, being amorphous, influences moisture absorption and flexibility.

Lignin provides rigidity and acts as a natural binder, but also imparts hydrophobicity. The proportion of these components varies with fibre type and extraction process, thus affecting mechanical, thermal, and moisture-related properties.

Physical and Mechanical Properties

Natural fibres possess densities in the range of 1.1 to 1.5 g/cm^3, significantly lighter than glass fibres (~2.5 g/cm^3), which contributes effectively to vehicle lightweighting.[1,3,16] They exhibit tensile strengths from 200 MPa (jute) up to 900 MPa (flax), and moduli from 10 to 70 GPa, depending on the fibre type and quality.

Fibre surface roughness, diameter (10–50 μm), and length influence the fibre–matrix interfacial adhesion and mechanical performance of NFCs. Moisture content (typically 6–12%) affects dimensional stability and long-term durability due to swelling and degradation phenomena.

Mechanical and Functional Properties

Natural fibre composites (NFCs) are increasingly valued in the automotive sector due to their balanced combination of mechanical performance and functional properties, which contribute to vehicle lightweighting and sustainability goals.[3,4,16] The mechanical performance of NFCs is primarily dictated by the properties of their natural fibre reinforcements, composite architecture, and fibre-matrix interface quality.[4,8,16]

Mechanical Properties of Natural Fibres

Natural fibres such as flax, hemp, jute, and kenaf generally present tensile strengths in the range of 200 to 900 MPa, with flax fibres often exhibiting the highest tensile strength and modulus (up to 70 GPa) due to their high cellulose content and crystalline microstructure.[3,5,16] Variability in fibre mechanical properties arises from plant species, harvesting conditions, and extraction methods. The relatively low elongation at break (typically 1–3%) provides moderate toughness suitable for composite reinforcement. Notably, their specific tensile strength and modulus (strength/density ratio) are comparable to or exceed those of glass fibres, making NFCs attractive for automotive lightweighting.[3,6,8]

Mechanical Properties of Natural Fibre Composites

In composites, natural fibres reinforce polymer matrices such as polypropylene (PP) or epoxy resins. The tensile strengths of NFCs range roughly from 30 to 120 MPa, while the tensile moduli vary between 3 and 15 GPa, largely influenced by the fibre volume fraction, fibre orientation, and surface treatment. Flax fibre composites have demonstrated tensile moduli exceeding 15 GPa and tensile strengths greater than 90 MPa, emulating conventional glass fibre composites used in vehicle interiors.[3,4,17]

Flexural properties follow similar trends, with composite flexural strengths reported between 50 and 150 MPa in practical automotive materials. The impact strength of NFCs is often superior to that of glass fibre composites because natural fibres dissipate energy through fibre debonding and pull-out mechanisms.[4,16] Such impact resistance is beneficial for automotive parts subject to dynamic loading and crash scenarios.

Surface Treatment and Fibre-Matrix Interaction

Natural fibres inherently display hydrophilicity due to their cellulose and hemicellulose content, leading to poor wetting by hydrophobic polymers, weak interfaces, and lower composite strength. To enhance adhesion, various chemical treatments, including alkali (NaOH), silane coupling, acetylation, and the use of compatibilizers such as maleic anhydride-grafted polypropylene (MAPP) have been widely studied. These modifications increase surface roughness and chemical affinity between fibres and matrices, improving tensile strength and water resistance.[6,18–21]

Functional Properties: Vibration Damping and Acoustic Insulation

Beyond mechanical strength, NFCs contribute valuable functional properties to vehicles:

Vibration damping

NFCs exhibit higher damping capacity than synthetic fibre composites, with loss factors (tan δ) between 0.06 and 0.1 in automotive-relevant frequency ranges (20–200 Hz). This superior energy dissipation reduces noise and vibration inside the cabin, enhancing passenger comfort without increasing weight.[22]

Acoustic absorption

Porous fibre mats provide sound absorption, reducing interior noise levels. NFCs combined with mineral fillers or foam layers further improve acoustic insulation performance, useful in door panels and dashboards.[23]

Environmental Durability Effects on Mechanical Properties

NFCs are sensitive to moisture ingress due to fibre hydrophilicity, which can cause swelling, fibre-matrix debonding, and degradation of mechanical properties by up to 30% after prolonged exposure.[24,25] Thermal degradation and UV radiation also shorten composite lifespan if unprotected. Recent developments in fibre treatment and bio-based matrices seek to enhance the environmental durability of these composites.[9]

Processing Techniques for Natural Fibre Composites

The selection and optimisation of processing techniques for natural fibre composites (NFCs) are critical to achieve the desired mechanical and functional properties while maintaining the environmental advantages essential to automotive applications. Natural fibres pose unique processing challenges, including sensitivity to temperature, moisture content, and fibre degradation, which influence manufacturing methods and final composite quality.[1,4,5,7,26]

Compression Moulding

Compression moulding is one of the most widely used manufacturing methods for NFCs in automotive production due to its ability to produce parts with complex shapes and adequate mechanical performance. In this process, fibre mats or preforms are combined with thermoset or thermoplastic polymers and moulded under heat and pressure. Compression moulding allows good fibre wetting and matrix impregnation, resulting in composites with high fibre volume fractions (typically 30–40%) and improved strength and stiffness.[3,5,8]

For example, flax fibre composites processed by compression moulding demonstrated enhanced mechanical properties, attributed to optimised consolidation and fibre alignment. The method's relatively low tooling cost and fast cycle times make it suitable for components like interior door panels and dashboards. However, fibre degradation can occur if processing temperatures exceed the thermal stability limits of natural fibres (generally below 230 °C).[27]

Injection Moulding

Injection moulding is preferred for the mass production of smaller, complex-shaped NFC parts. In this technique, short natural fibres are compounded with thermoplastic polymers (such as polypropylene) and injected into moulds. Although conventionally used with synthetic fibres, recent advances enable NFCs in injection moulding, providing rapid production capabilities and design flexibility.[28–30]
Challenges include fibre length reduction during compounding and shear-induced damage, which can adversely affect mechanical properties. Compatibilizers, such as maleic anhydride-grafted polypropylene, improve fibre dispersion and interfacial adhesion. Application areas include interior trims and small structural elements, where high precision and dimensional stability are required.[26,31]

Resin Transfer Moulding (RTM)

Resin Transfer Moulding involves placing dry fibre preforms into closed moulds, followed by injecting resin under pressure. RTM can achieve high fibre volume fractions and uniform resin distribution, resulting in composites with excellent mechanical strength and surface quality. The method suits medium to large-sized components requiring high performance, such as semi-structural panels and battery housings.[26,32]

The main limitations of RTM for NFCs include longer cycle times and higher costs relative to compression moulding, as well as the need for precise control of resin flow to prevent dry spots. Nonetheless, RTM offers potential for high-quality NFC parts in premium automotive segments.[33]

Extrusion and Thermoforming

Extrusion processes compound natural fibres with thermoplastic matrices to produce pellets or sheets. These can be further formed into desired shapes by thermoforming, enabling rapid production of relatively simple geometries. This combination is suitable for applications like cladding components and non-structural panels.

Extrusion processing requires strict moisture control, as water content causes fibre degradation and void formation. Thermoforming allows customisation of mechanical properties through control of fibre orientation and volume fraction. The ease of recycling thermoplastics additionally complements the sustainability of NFC parts made by extrusion and thermoforming.[29]

Fibre Treatment and Impact on Processing

Physical and chemical surface treatments of natural fibres enhance processing by improving fibre-matrix adhesion and thermal stability. These treatments reduce hydrophilicity, limit moisture uptake during manufacturing, and prevent agglomeration in composites. Typical treatments include alkali, silane, acetylation, and plasma treatments applied before compounding or moulding.[29–31]

Hybrid Processing Techniques

Hybrid manufacturing, combining natural fibres with synthetic fibres or other reinforcements, is gaining interest to balance sustainability with enhanced mechanical and thermal performance. Co-extrusion, layering, and co-moulding techniques enable the fabrication of hybrid composites tailored for specific automotive requirements.[34–36]

The work of Lefeuvre et al. highlighted the potential of flax–glass hybrid laminates produced via compression and RTM methods, achieving high strength-to-weight ratios suitable for semi-structural vehicle components. [34] Such hybridization strategies allow tailoring of stiffness and impact performance while maintaining a significant proportion of renewable content in the composite.

Environmental & Sustainability Aspects

The environmental advantages of natural fibre composites (NFCs) are a core driver for their incorporation in automotive applications. Sustainability considerations include renewable feedstock usage, reduced carbon footprint, energy consumption during production, and end-of-life disposal or recycling options. This section explores these aspects in detail, situating NFCs within the broader context of green automotive materials development.[37]

Renewable and Biodegradable Resources

Natural fibres used in composites originate from renewable crops such as flax, hemp, jute, and kenaf, which can be regrown annually or seasonally. Unlike synthetic reinforcements derived from non-renewable petroleum-based sources, natural fibres are biodegradable, reducing environmental persistence and associated waste management challenges. The biodegradability of NFCs facilitates integration within circular economy models, allowing for composting or energy recovery at end-of-life. However, fibre biodegradation rates depend on environmental conditions and composite formulation, where polymer matrix type (thermoplastic versus thermoset) plays a significant role in ultimate biodegradability.[37,38]

Life Cycle Assessment (LCA) and Carbon Footprint

Life cycle assessments quantify the environmental impacts of NFC production, use, and disposal relative to conventional composites. Studies consistently show substantial reductions in embodied energy and CO_2 emissions for NFCs compared to glass fibre reinforced composites (GFRCs). For example, Bledzki and Gassan reported that flax fibre production consumes approximately 50–85% less energy than glass fibre manufacturing.[7] Similarly, Yan et al. demonstrated that NFCs reduce total carbon footprint by up to 40%–60% depending on region and processing routes.[6]

Environmental savings stem from lower agricultural inputs for fibre cultivation, reduced energy intensity in fibre processing compared to synthetic fibre production, and lower weight contributing to fuel savings during vehicle operation. However, LCAs also highlight the influence of transportation distances, farming practices, and composite processing energy on overall sustainability.[37,38]

End-of-Life Considerations

Disposal and recycling options critically impact sustainability credentials. NFCs based on thermoplastic matrices like polypropylene can be mechanically recycled, albeit with some fibre degradation. Thermoset-based NFCs are less amenable to recycling but can be incinerated for energy recovery, with lower emissions compared to synthetic composites.

Advancements in biodegradable polymer matrices, combined with natural fibres, enable fully compostable composite systems; however, such materials are in early development for automotive-scale use. Strategies to improve the end-of-life recyclability include bio-based resin development, hybrid material design, and separation technologies.[37,38]

Regulatory and Market Influences

Governments worldwide enforce stringent emission and sustainability regulations that incentivise the automotive sector to adopt eco-friendly materials. The European Union's Green Deal and fuel economy standards promote lightweight, bio-based composites to reduce life cycle greenhouse gas emissions. OEMs integrate NFCs to meet consumer demand for "green" vehicles and to improve corporate sustainability rankings. These environmental and market drivers reinforce ongoing R&D investment in NFCs.[39–42]

Automotive Applications of Natural Fibre Composites

Natural fibre composites (NFCs) are increasingly being adopted in the automotive sector to fulfil demands for sustainable and lightweight materials with sufficient mechanical performance. They enable vehicle mass reduction, cost savings, and lower environmental impact compared with glass fibre–reinforced composites (GFRCs).[26,43] Figure 1 illustrates various automotive components produced using polymer composites reinforced with plant-based natural fibres. The following subsections outline key application domains and industrial developments.

Interior Components

Interior parts represent the earliest and most extensive applications of NFCs in automobiles. These include door panels, dashboards, parcel shelves, seat backs, and consoles. NFCs offer excellent acoustic damping and thermal insulation, improving passenger comfort and reducing overall weight.[26] Jute, flax, and kenaf fibre–reinforced polypropylene (PP) composites are widely used in these components due to their balance of stiffness, toughness, and recyclability.[43,45]

Manufacturers such as BMW and Volkswagen have successfully used flax and jute composites in door and interior panels, achieving weight reductions up to 30% compared to GFRCs while improving sustainability performance.[1,46] Furthermore, the inherent vibration damping of NFCs enhances noise reduction in vehicle cabins.[38,46]

Exterior Semi-Structural Components

Natural fibre composites have found increasing use in exterior components that require moderate load-bearing capabilities, such as bumper reinforcements, fender liners, trunk liners, and wheel arch liners. Flax and hemp composites demonstrate low density and high specific stiffness, contributing to fuel efficiency and improved handling.[4] Compression moulding and resin transfer moulding (RTM) enable complex geometries and surface finishes compatible with automotive design requirements.[47]

Volvo and Ford have implemented hemp- and flax-reinforced composites in semi-structural parts, illustrating their durability and commercial feasibility.[48]

Figure 1 : Automotive components manufactured from polymer composites reinforced with plant-based natural fibres.[44]

Structural and Load-Bearing Elements

While still emerging, NFCs are being explored for structural components that demand higher mechanical integrity and safety, including seat frames, door impact beams, and battery enclosures in electric vehicles. Hybrid composites that combine natural and synthetic fibres offer enhanced tensile and flexural strength while preserving environmental advantages.[3] Advances in fibre treatment and bio-based matrix materials further improve crashworthiness and fatigue life.[6,49]

Case Studies of OEM Adoption

Several original equipment manufacturers (OEMs) have pioneered NFC use at commercial scale. BMW integrated flax fibre composites in the 3-Series (E46) for door panels and trunk liners, achieving about 30% weight reduction.[43]

Volkswagen introduced jute-reinforced PP composites in models such as the Golf and Passat to meet sustainability and cost objectives.[1]

Volvo adopted hemp and flax composites for interior and semi-structural components within its electric vehicle programs, aligning with corporate carbon-neutrality targets.[4] These examples highlight NFCs' growing acceptance as viable substitutes for conventional composites in mainstream automotive manufacturing.

Future Trends in Automotive NFC Applications

Research advancements and stricter sustainability regulations are accelerating NFC adoption. Ongoing developments include fibre surface modification for better interfacial bonding, bio-based polymer matrices for improved recyclability, and hybrid reinforcement strategies for enhanced performance.[3,49]

With increasing emphasis on life-cycle emissions and recyclability, NFCs are expected to play a central role in electric and autonomous vehicle platforms prioritizing lightweight and eco-friendly materials.[46]

Benefits and Challenges

Natural fibre composites (NFCs) offer a range of benefits that make them attractive candidates for automotive applications, but they also present challenges that must be addressed to fully realize their potential. This section provides a balanced examination of the advantages and limitations of NFCs in automotive contexts.

Benefits

Lightweighting and Mechanical Performance

NFCs provide substantial weight savings compared to traditional glass fibre composites and metals due to the lower density of natural fibres (1.1–1.5 g/cm^3) compared to glass fibres (~2.5 g/cm^3) and steel (~7.8 g/cm^3).[26,43] This lightweighting directly contributes to improved fuel efficiency and reduced CO_2 emissions during vehicle operation.[42]

Although natural fibres exhibit lower absolute tensile strengths compared to synthetic fibres, their specific strength and stiffness are comparable when using bast fibres such as flax, hemp, and jute.[3,6] Furthermore, NFCs exhibit favourable energy absorption characteristics, which improve crash performance and occupant safety.[50]

Sustainability and Environmental Impact

The renewable nature of natural fibres significantly lowers the embodied energy and carbon footprint of NFC components relative to synthetic composites. [4,51] Life cycle assessments have shown that NFCs can reduce greenhouse gas emissions by 40-60% compared to glass fibre reinforced plastics (GFRPs).[52] Their utilisation also supports agricultural sustainability by converting crop residues such as hemp shives, jute stalks, and flax waste into high-value products.[45] The adoption of bio-based matrices further promotes circularity and reduces dependence on petroleum-derived polymers.[53]

Cost-Effectiveness and Processability

Natural fibres are cost-effective compared to glass and carbon fibres, offering potential material cost savings of 20–40%.[49] NFCs can be processed using conventional techniques such as compression moulding and injection moulding without extensive modification of existing equipment.[46,54] Their relatively low thermal processing requirements (typically below 200 °C) lead to lower energy consumption during manufacturing.[55]

Functional Benefits

Beyond mechanical and environmental performance, NFCs exhibit superior acoustic damping and thermal insulation properties compared to synthetic composites, improving passenger comfort in vehicle interiors.[1]

Their unique aesthetic appearance, including natural texture and color, enables visual differentiation in eco-conscious product design and aligns with the growing market demand for sustainable automotive interiors.[56]

Challenges

Moisture Sensitivity and Durability

The hydrophilic nature of plant fibres causes moisture absorption, swelling, and degradation of fibre–matrix adhesion, which in turn diminishes mechanical performance under humid or cyclic conditions.[25,57] Prolonged exposure to moisture and temperature variations can accelerate fungal growth and fibre degradation, compromising component longevity.[55]

Variability and Quality Control

Natural fibres exhibit variability in chemical composition (cellulose, hemicellulose, lignin content) and morphology depending on plant species, growing conditions, and processing routes.[48] This inherent variability leads to inconsistent composite performance and complicates quality assurance in high-volume automotive manufacturing.[58]

Thermal Stability and Processing Limitations

Thermal degradation of natural fibres begins around 220–270 °C, restricting their use with high-temperature polymers such as polyamide or PEEK.[59] Processing above this threshold results in discoloration, off-gassing, and reduced tensile strength. This limitation confines NFC production mainly to thermoplastic matrices such as polypropylene, polyethylene, or PLA.[1,3]

Fibre-Matrix Adhesion

Natural fibres' hydrophilic surfaces are incompatible with hydrophobic polymer matrices, resulting in weak interfacial bonding and inefficient load transfer.[60] Chemical surface treatments (alkali, silane, acetylation) and compatibilizers such as maleic anhydride–grafted PP have been used to enhance adhesion, though industrial scalability and consistency remain challenging.[7,55]

Recycling and End-of-Life Considerations

While the natural fibre fraction in NFCs is biodegradable, recycling of polymer matrices—especially thermosets—remains limited.[4] Advances in biodegradable thermoplastic matrices and mechanical recycling techniques aim to develop fully recyclable bio-composites, yet large-scale implementation is still in progress.[61]

CONCLUSION

Natural fibre composites have emerged as highly promising materials for sustainable and lightweight automotive applications. Their renewable origin, biodegradability, and favourable specific mechanical properties provide a clear environmental advantage over traditional synthetic fibre composites and metals widely used in the automotive sector. NFCs demonstrate sufficient mechanical strength, stiffness, and impact resistance needed for a broad range of interior, semi-structural, and some emerging structural components in vehicles. Additionally, their intrinsic functional properties, including superior vibration damping and acoustic insulation, contribute positively to passenger comfort.

The integration of natural fibres such as flax, hemp, jute, kenaf, and sisal into polymers facilitates significant vehicle weight reductions, thereby supporting fuel efficiency and reduced greenhouse gas emissions throughout vehicle lifecycles. Life cycle assessment studies emphasize NFCs' potential to reduce embedded energy and carbon footprints substantially compared to conventional materials.

Nevertheless, challenges remain to fully exploit the potential of NFCs. Moisture sensitivity of natural fibres, variability in fibre quality, limitations in thermal processing windows, and interfacial compatibility with polymer matrices require targeted research. Advances in fibre surface treatments, bio-based matrix development, hybrid composite architectures, and scalable manufacturing technologies are ongoing to address these issues.

Future research and industry efforts should emphasize improving NFC durability and environmental resistance, enhancing recycling and biodegradability, and developing standards that ensure consistent fibre quality and composite performance. With continued technological innovation and regulatory support, NFCs are well-positioned to become mainstay materials in the automotive sector's pursuit of sustainable, lightweighting solutions.

The combined benefits of environmental sustainability, weight savings, and functional performance underscore the growing importance of natural fibre composites in shaping the future of automotive materials, fulfilling both industry goals and consumer demands for greener mobility.

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