CENTRE FOR HIGH CARBON CAPTURE CROPPING

TOPIC SHEETS

Biocomposites

From Egyptians to aerospace: Biocomposites accelerating into the future

When early Egyptian and Mesopotamian settlers used a mixture of mud and straw to create their buildings, they may not have thought this method would endure for over 3,500 years. This form of basic but strong and durable construction is the ancestor of a modern, fast-growing, highly innovative and technical biocomposite market that serves multiple industries and applications. This sheet focuses on performance composites generally, and the more specific biocomposite market.

What are biocomposites?

Composites are engineered materials composed of two primary components: a binder, known as the 'matrix' holding the structure together and distributing loads; and reinforcing fibres, which can be woven or non-woven, providing strength and stiffness. When one or both elements are derived from bio-based sources, the resulting material is referred to as a 'biocomposite'. Traditionally, both components have been made from synthetic, often non-renewable materials, such as petroleum-based resins and glass or carbon fibres.

However, the majority of biocomposites currently in use feature natural reinforcing fibres such as flax, hemp, jute, kenaf, or wood fibres. These types of biocomposite are commonly referred to as 'natural fibre reinforced plastics' (NRPs).

While significant progress has been made in developing bio-based reinforcing fibres, the matrix—or binder—component of composites remains a greater technical challenge. Plant oils such as those derived from hemp, linseed, or castor are being used to formulate bioresins, but achieving the mechanical, thermal, and processing performance required for industrial applications has often necessitated blending with synthetic components.

SHD Composites

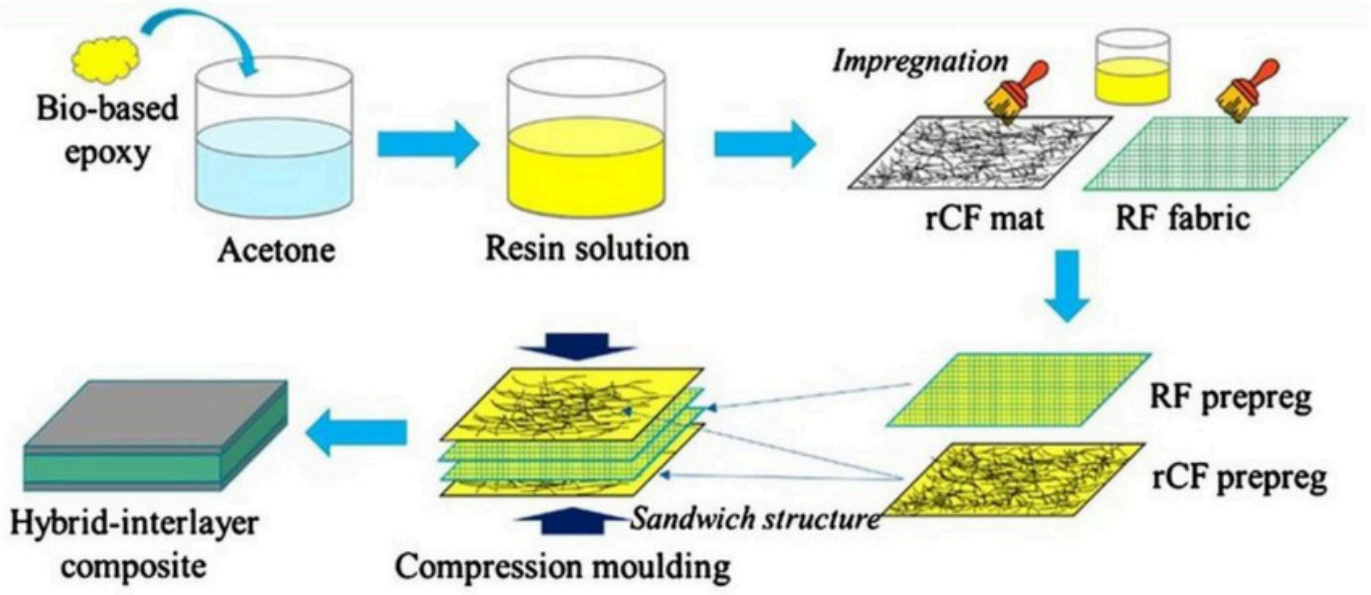
Specialists in advanced composite prepreg materials, SHD Composites are collaborating with CHCx3 partners to explore the performance of UK grown hemp and flax fibres in their matrix materials. These fibres will be integrated into SHD's existing resin systems to form high-performance composite panels designed for automotive, aerospace, and other advanced applications. Having previously used imported hemp materials, SHD sees this as a pivotal opportunity to develop local supply chains, thereby reducing environmental impacts associated with long-distance transportation. This move supports a broader shift toward regional sourcing and enhances the sustainability profile of their composite products without compromising on quality or performance.

As a result, most commercially available technical bioresins currently used in composites contain only up to 30% bio-derived content. This partial substitution helps reduce reliance on petrochemicals but falls short of fully sustainable material goals. CHCx3 partners are working to change this to develop 100% bio-based resin systems. Notably, BitRez is advancing fully bio-derived thermosetting resins aimed at automotive and aerospace applications—sectors with stringent performance requirements. Meanwhile, Vitality Acoustics is exploring 100% bioresins in their acoustic panel solutions, combining sustainability with sound performance.

UK employee-owned Scott Bader—global manufacturer of adhesives, composites and functional polymers—has developed Crestafire® Bio P1-8001, a 100% bio-based resin derived from lignocellulosic sugar cane waste that achieves EN45545-2 HL3, the highest fire performance rating for rail applications in Europe. What sets Crestafire Bio P1-8001 apart is its inherently excellent fire, smoke, and toxicity (FST) performance and may have additional benefits of moisture, mould and pest control. Its properties open new opportunities for biocomposites in safety-critical environments, such as public transport, aerospace, and construction, where fire retardancy is essential.

These efforts signal a critical shift toward truly circular and renewable composite materials, offering the potential to eliminate fossil-based content without compromising quality.

The biocomposite manufacturing process



The illustrated process flow above shows the fabrication of a hybrid-interlayer composite using a bio-based epoxy, recycled carbon fibre (rCF) mats, and reinforcement fabrics (RF). The first step involves dissolving the bio-based epoxy in acetone, to form a resin solution.

The resin solution is then used to impregnate the rCF mats and RF fabrics, which results in rCF end RF prepreg. The prepregs are layered alternately to form a sandwich structure, combining the rCF and RF materials. The sandwich structure is then compression moulded to produce the final hybrid-interlayer composite.

BMW i Ventures

In 2022, BMW i Ventures invested in high-performance composites made from natural fibres by acquiring a stake in Bcomp. In 2019, the flax cooling shaft on the BMW iFE.20 made it the first BMW racing car with parts constructed from renewable plant fibres.[1]

Bcomp's patented range of flax-based reinforcement fabrics—powerRibs and ampliTex—are technologies that can be used by OEMs as substitutes for standard materials like carbon and glass fibre or plastic in its target markets.

In specific applications, powerRibs and the ampliTex technical fabric ranges offer high lightweighting and stiffness potential relative to synthetic composites. The materials also offer high vibration damping and enhanced safety, as the materials do not shatter upon impact.

A growing market

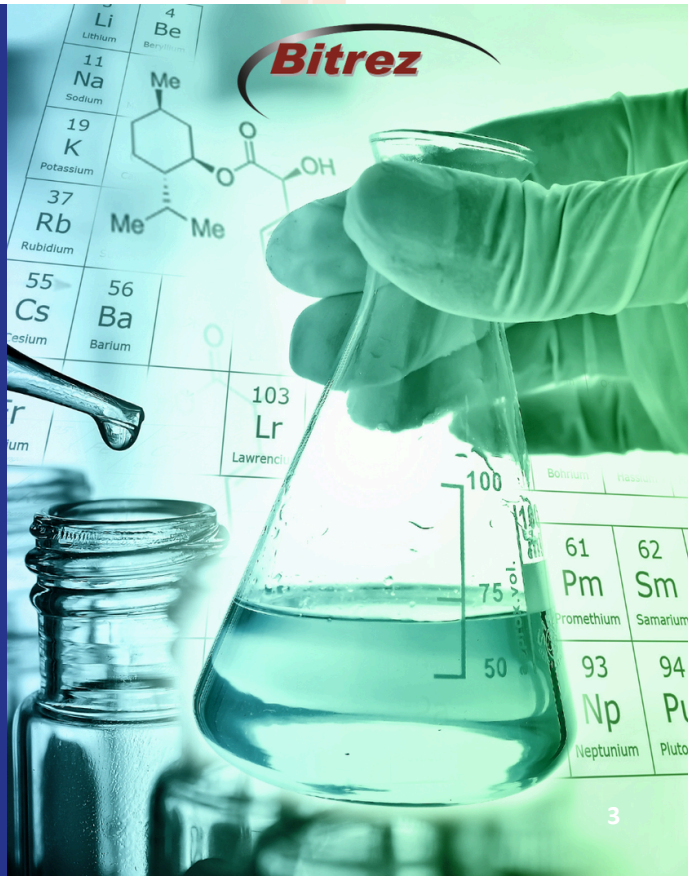
In 2024, the global market for composites was estimated to be worth $117 billion and is forecast to grow at 6% annually to 2030. This growth is primarily driven by the aerospace, automotive, construction, marine, and renewable energy industries, where the lightweight and high-strength materials are essential.[3]

The biocomposites sector has been expanding due to heightened environmental awareness and regulatory measures promoting eco-friendly alternatives to conventional materials.[4] Globally, the biocomposites market grew from $7.34 billion in 2012 to $24.63 billion in 2022, showing a very healthy compound annual growth rate (CAGR) of 12.87%, which is expected to increase to 17% by 2032, resulting in a market worth $116.53 billion by 2032.[5] Biocomposite markets have demonstrated strong resilience amid recent economic uncertainties –while other composite sectors have slowed or declined, natural fibre reinforced plastics (NRPs) have continued to grow.

BitRez

BitRez, a leading innovator in advanced polymers, is developing a suite of green chemistry solutions to include bio-epoxy resins, bio-based curing agents, and bio-phenolic resins (PFA)—all derived from renewable, sustainable plant sources. These bioresins are engineered to replicate the high-performance characteristics of traditional epoxy resins, making them ideal for biocomposite applications in the automotive and construction industries.

As part of the CHCx3 project, BitRez is now exploring the conversion of hemp seed oil into a thermosetting resin tailored for biocomposites. This development will utilise hemp-based textiles provided by Camira, creating a fully bio-based composite material.[2]



Extensive potential

Aerospace, automotive and wind turbine sectors in particular prize lightweight, high strength materials, which has driven a surge in demand in composites. Combined with environmental regulations, carbon targets, end of life requirements and sustainability goals, these industries are increasingly looking to use bio-based constituents.

Uptake of composites in the construction industry is also rapidly expanding, such as use in bridges, building facades, and other structures, with a growing interest in incorporating natural fibres. For more examples in this sector, refer to the Construction Topic Sheet.[6]

Consumer goods are also a large sector for composites, covering electronics, sports equipment, bathtubs, furniture, bicycles, packaging and more. The potential for medical devices using precision composites manufactured by 3D printing is opening up new higher value opportunities. In addition, composites can be designed for anti-corrosive environments and can be used for industrial pipes and tanks, and equipment casings.[7]

Volkswagen

In August 2024, Volkswagen entered a cooperation with the German start-up Revoltech GmbH from Darmstadt. The aim is to research and develop sustainable materials based on industrial hemp. They are developing an imitation leather made from 100% bio-based hemp using local residues. It can be produced on existing industrial plants and recycled or composted at the end of its life. They hope to use it as a surface material in their cars from 2028.[8]

Functional and sustainable superpowers

Composite components provide more sustainable options due to their high-performance properties such as lightweighting, strength, thermal stability, and corrosion resistance. These characteristics deliver long-lasting solutions and reduce energy consumption, thus making a substantial contribution to decarbonisation and material reduction.[9]

Plus, bio-based composites have added benefits over conventional composites. For example, natural fibres from crops such as flax can be just 20% per unit of the weight of glass fibre, and the carbon footprint from natural fibres production can be negative, owing to the carbon capture during its growth.[10] Biocomposites also offer excellent potential as 'circular materials' within a circular economy. In other words, due to their natural composition there are numerous options for their reuse and recycling at end of life e.g. as modular panels that can be deconstructed and then reused, or through industrial biodegradation into compost to go back onto the land for crops.

Natural fibre-reinforced plastics are often used due to their special material functionality such as mechanical, acoustic and vibrational properties. For example, the acoustic properties of hemp are excellent and can be used to dampen sound or vibration in music studios, offices and public spaces. Visually, natural fibres provide an aesthetic natural finish which cannot be produced from synthetic fibres.

BioTwin

BioTwin has developed biocomposite wall studs to replace steel. Their strong, sustainable BioStuds are made from hemp-based composites. With a 28% lower carbon footprint than standard steel studs, and proven fire resistance these are lighter, durable and acoustically superior to steel studs.

Innovation at the cutting edge

There are still many opportunities to further develop functional biocomposites for modern applications across multiple industries. Currently, there are few 100% biobased resins to make up the binding matrix material, and the full extent of the potential functional properties of different natural fibres have not been fully explored. The CHCx3 project is supporting the UK supply chain to develop cutting-edge, innovative materials in this space.

Several policy factors are driving biocomposite adoption across automotive, construction, and packaging industries. Extended Producer Responsibility regulations require manufacturers to manage materials through their entire lifecycle, while Net Zero commitments push companies toward lighter, lower-carbon alternatives. These pressures make biocomposites increasingly attractive, helping companies meet both regulatory requirements and sustainability goals.

The UK bio-based composites market is a nascent but high-potential space. With the right combination of innovation, investment, and policy alignment, it presents strong opportunities in sectors that are transitioning to more sustainable and circular materials. Manufacturers and research and technology organisations can benefit from this shift, especially those that focus on cost-effective, scalable, and high-performance biocomposite solutions.

BIOntier

The BIOntier EU funded project is exploring various applications for biocomposites including a structural impact absorber for the Egea hatchback, battery pack housing, an access panel for TAI aircraft with specialist thermal and mechanical properties, and high- and low-pressure tanks for hydrogen and reverse osmosis systems.[11]

Vital Accoustics

Vital Acoustics' VA23 acoustic panel is crafted from UK-grown hemp and bio-based resins, offering Class C sound absorption, VOC-free materials, alongside carbon-negative performance of minus 4.62kg CO2eq per panel. It outperforms conventional materials in sound absorption, sustainability, and air quality. Made to LEED (Leadership in Energy & Environmental Design), WELL (health and wellbeing of occupants), and BREEAM standards, it can be used in commercial, educational and residential spaces.[12]

Network Rail

In February 2023, Network Rail opened the innovative FLOW Bridge in Shropshire—a fibre-reinforced polymer bridge that's Faster, Lower cost, Optimised, and a Working solution replacing a dangerous level crossing. KS Composites manufactured the concrete-free 21-metre structure using glass, carbon, and flax fibres. This unique blend created a bridge 50% lighter than steel and 40% cheaper to build. The bridge's offsite construction enables rapid installation while reducing weight, transport costs, and carbon footprint.[13]

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