As published in JEC Composites Magazine, N°167, March - April 2026 (https://www.jeccomposites.com)

resin

Low-footprint epoxy with tunable latency enables recycled carbon fibre mat adoption

Martino Lamacchia,
Global Product and Marketing Manager,
Composites,
Olin

As net-zero and Scope 3 targets reshape material priorities, carbon footprint has become a critical barrier for composites. This article presents a low-footprint epoxy system for HP-RTM and wet pressing with tunable latency that not only reduces emissions directly but also enables the use of recycled carbon fibre mats – materials previously limited by poor permeability. By overcoming impregnation challenges, Olin presents new pathways for sustainable, high-performance composite manufacturing.

Over the past 20 years, composite materials have been instrumental in reducing fleet emissions, largely due to their remarkable strength-to-weight ratio. By enabling vehicles to shed excess mass, composites have directly contributed to improved fuel efficiency and reduced CO_2 emissions. The US Department of Energy's "Lightweight Materials for Cars and Trucks" report, published in 2013, highlights that a 10% reduction in vehicle weight can yield a 6-8% improvement in fuel economy.

With the rise of electrification, composites have become even more critical. Lightweight structures directly impact battery range, which is a key performance metric for electric vehicles. According to the McKinsey report, "Lightweight, heavy impact: How lightweight materials will shape the future of automotive," published in January 2022, every 100 kg of weight reduction can increase EV range by up to 10%, making composites indispensable in next-generation vehicle design.

Scope 3 emissions and OEM targets

As OEMs pursue net-zero goals, Scope 3 emissions – those generated across the supply chain – have come under intense scrutiny. According to Deloitte's 2023 report "Automotive's Carbon Dilemma: Decarbonizing the Supply Chain," Scope 3 emissions can account for up to 98% of an automotive company's total carbon footprint. Yet, despite their significance, a joint analysis by the World Economic Forum and Boston Consulting Group in the 2022 publication "The Drive Toward Net-Zero: Accelerating Supply Chain Transformation in the Automotive Sector" found that OEMs have only reduced upstream Scope 3 emissions by about 2% since 2017, while Tier 1 suppliers have actually increased them by 5% during the same period. To address this gap, the Science Based Targets initiative (SBTi) recommends a minimum 2.5% annual reduction in Scope 3 emissions – amounting to a 25% reduction over a decade – to remain on track with global climate commitments.

Carbon footprint: a new barrier for composites

While composites offer clear benefits in lightweighting and performance, their production – especially of virgin carbon fibre and epoxy resins – is energy-intensive and carbon-heavy. This presents a barrier to adoption in a market increasingly driven by Scope 3 reduction targets. To remain viable, composites must evolve to meet both performance and sustainability demands.

The industry needs a resin system that supports mass production of lightweight composites while minimising carbon footprint. Such a system must also enable the use of low-footprint reinforcements, like recycled carbon fibre mats and natural fibres, which are often challenging to impregnate due to their structure and variability.

The solution: Litestone® VF 4500 HP-RTM/LCM system

Olin Sustainaline® Litestone® VF 4500 system (Table 1) emerges as a compelling answer for the mass production of high-performance composites.

Tab. 1: Typical clear cast and composite properties achievable (Matrix: Litestone® VF 4500, reinforcement: DowAksa A42 carbon fibre, fibre volume fraction: 49%, production process: HP-RTM)

Process: HP RTM	Test Standard	VF 4500
Clear Cast Data		
Elongation at Break	ISO527-2	7 %
Elastic Modulus	ISO527-2	2.8 GPa
Tensile Strength	ISO527-2	68 MPa
Composite Data (DowAksa A42 carbon r, 49 Vol %)		
Tg Mid-point (DSC)		120°C
0° Tensile Modulus (0/90° fabric)	ISO527-4	63 GPa
0° Tensile Strength (0/90° fabric)	ISO527-4	960 MPa
0° Elongation (0/90° fabric)	ISO527-4	1.4 %
90° Tensile Modulus (UD fabric)	ISO527-4	8.2 GPa
90° Tensile Strength (UD fabric)	ISO527-4	59 MPa
90° Elongation (UD fabric)	ISO527-4	1.1 %
Fracture Toughness K1C	ISO13586	1.3 MPa√m
Fracture Toughness G1C	ISO13586	900 J/m²
Composite Density		1.49 g/cm³

Designed for HP RTM and LCM applications, it enables curing times as fast as two minutes, allowing manufacturers to scale up production while upholding stringent quality and sustainability standards.

The sustainability advantage of the VF 4500 system is addressed in two key ways: directly, by reducing the resin system's own carbon footprint, and indirectly, by enabling the effective use of recycled and low-footprint reinforcement materials.

Direct reduction potential: lowering the resin system footprint

Central to the environmental benefit is Olin's vertically integrated production model, which ensures that most of the necessary raw materials are produced onsite. This approach significantly reduces the product's environmental impact. The standard VF 4500 system, in fact, already delivers a 26% reduction in carbon footprint (Figure 1) compared to industry averages. The Sustainaline® variant, available in Europe and certified ISCC+ at Olin's Stade plant in Germany, further advances this achievement, enabling up to 40% lower emissions than conventional similar epoxy systems. By lowering the baseline footprint of the resin itself, the system delivers an immediate, measurable sustainability benefit – especially when used in composites reinforced with low-carbon footprint fibres.

Indirect reduction potential: enabling use of recycled carbon fibre and natural fibres

Equally important is the system's compatibility with sustainable reinforcements. Decades of epoxy resin expertise and robust application R&D have led Olin to develop a tunable rheology profile for VF 4500, which is very valuable to overcome the challenges posed by natural fibres and recycled carbon fibre mats. These materials often have significantly lower permeability than traditional woven glass or carbon textiles, making them difficult to impregnate with standard resins. VF 4500's very low initial viscosity ensures thorough wetting of these challenging structures, while its latent behaviour supports rapid curing once impregnation is complete. This not only streamlines the manufacturing process but makes it feasible to incorporate recycled carbon fibres, which can reduce the composite's footprint by up to 80% compared to using virgin carbon fibre (Oliveux et al., Composites Part A, 2015).

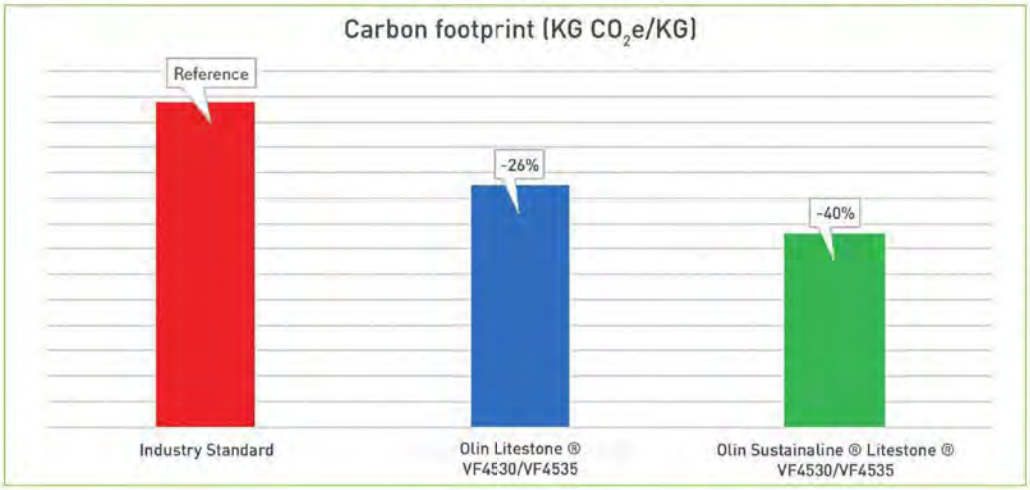

Fig. 1: Carbon footprint reduction potential. The assessment for industry average is based on relevant industrial databases and manufacturer data. For Olin products, carbon footprint calculations are based on internal assessments following the guidelines of ISO 14040 series of LCA standards.

Fig. 2: Wet pressing of a recycled carbon fibre mat (courtesy of Cannon)

Thus, the system amplifies the sustainability impact across the entire value chain by facilitating broader adoption of recycled and renewable materials.

In virgin carbon fibre composites, the carbon footprint is primarily driven by the production of virgin fibres. The article "Life Cycle Assessment of Carbon Fibre-Reinforced Polymer Composites" by Das (2011) reports that producing 1kg of virgin carbon fibre from PAN precursor can emit up to 29 kg CO_2-equivalent, due to the energy-intensive stabilisation and carbonisation processes. This high footprint makes it especially challenging for OEMs with ambitious Scope 3 targets to decarbonise composite-intensive applications.

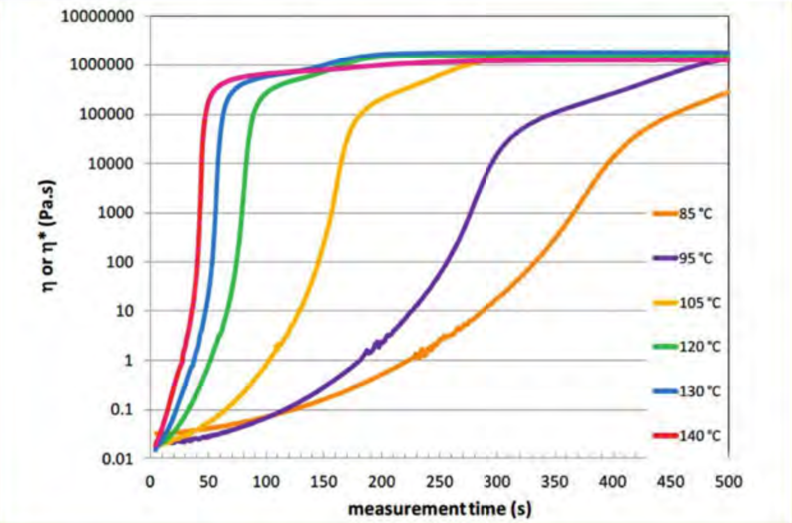

Fig. 3: Rheology of LITESTONE ® VF 4500 Epoxy System. The latent behavior favors the impregnation of low permeability reinforcements. Unlike other low-viscosity chemistries, LITESTONE ® VF 4500 is non-flammable and does not require ATEX-certified injection equipment

Where technically feasible, using recycled carbon fibre mats is a promising solution, potentially lowering the composite's footprint by up to 80% (Oliveux et al., Composites Part A, 2015). Yet, these mats pose a key challenge: their in-plane permeability is much lower than that of woven fabrics – often as low as 1×10^{-10} m^2 (Park et al., Composites Part A, 2012) – making impregnation with standard resins difficult and limiting their broader adoption.

Here, the latent behaviour of Olin's VF 4500 system provides a solution. Its tunable rheology ensures very low viscosity during injection – critical for thoroughly wetting recycled carbon mats – then rapidly cures once impregnation is complete.

As a consequence, VF 4500 not only lowers composite carbon footprint directly through its own low-emission chemistry but also indirectly by enabling manufacturers to effectively use recycled carbon mats, amplifying the sustainability impact across the value chain.

With Olin Sustainaline® Litestone® VF 4500, the automotive industry gains a versatile solution to advance both lightweighting and sustainability goals. This ultra-low-footprint, fast-curing epoxy system enables the effective use of recycled carbon fibre mats – materials that were previously difficult to process in high-throughput applications like HP-RTM or wet pressing (Figure 2).

When combined, this resin and reinforcement approach (recycled carbon mat and Olin Sustainaline Litestone VF 4500) offers the potential to reduce the carbon footprint of carbon composite components by up to 64%, based on typical mass fraction scenarios. Such integration supports meaningful progress towards Scope 3 emission targets and contributes to the development of cleaner, more efficient mobility solutions (Figure 3). □

More information:
www.olin.com