Novel Additives Promise Strong, Lightweight Composites for Commercial Transportation

Lightweight structural components are often made with advanced fiber-reinforced composites due to their high specific strength. However, in comparison to their metal counterparts, composites are more susceptible to harm from low-velocity impacts. Impacts can cause separation of the composite layers, a phenomenon known as delamination, which can reduce strength and stiffness and lead to catastrophic failure. This factor and the cost of manufacturing have prevented the introduction of viable weight-saving composite materials in place of traditional metal-based high-performance materials.

To address the issue of material toughness in composites, additives such as carbon nanotubes, nanoclay, and nanosilica have been tested over the years. While they presented promising bench-scale results, they can be difficult to add to composite polymer matrices because of poor dispersion and incompatibility in large-scale manufacturing processes. These challenges have impeded widespread adoption of composites. Thus, to enable the large-scale adoption of composites, key challenges of delamination and scalable, cost-effective composite manufacturing need to be overcome.

Enter MITO Material Solutions, a startup headquartered in Indianapolis, IN. With support from the National Science Foundation (NSF), the company has developed novel hybrid additives that improve composite material properties and are compatible with large-scale manufacturing. MITO's new additives are a blend of a physical filler and chemical modifier.

The company's first commercial product, MITO E-GO, uses nanoscale graphene as a filler and as a scaffold for attaching an epoxide-functionalized silica cage structure. The hybrid additive bonds the composite's polymer resin and the fibers more effectively, creating a more-structured matrix and reinforcing the area between layers with chemically bonded truss joints. MITO scientists have developed a drop-in formulation of the additive that reactively disperses throughout liquid and solid polymers. The use of functionalized nanofillers that are chemically compatible and dispersible in various resins is MITO's key innovation.

The hybrid additive allows formulators to improve thermal and mechanical properties of composites. In lab and in field tests, additive loadings as low as 0.1 wt% resulted in substantial improvements in interlaminar toughness and flex strength compared to incumbent fiberglass and carbon fiber systems. The company's drop-in technology enables the pursuit of durable composites to lighten the weight of applications while increasing environmental benefits.

MITO's hybrid additives are already being used commercially to enhance high-performance sporting goods. The company is now working with Wabash, a large North American manufacturer of trailers and truck bodies, to address the lightweighting needs of commercial transportation for greater sustainability.

In real-world testing with Wabash, the E-GO product was dispersed on-site and showed good dispersion under ultrasound review. Studies concluded that the addition of the hybrid additive increased the composite laminate's strength and toughness anywhere between 20% and 135% when compared to the baseline. This trial demonstrated the viability of a cheaper material in a side-by-side comparison with a more expensive resin-fiber combination. The team's next step is to assess long-term durability.

With the E-GO hybrid additive, MITO is creating a path to enhanced composites with the durability of metals, and Wabash is closer to revolutionizing their industry with the first all-composite trailer — projected to be anywhere between 30% and 40% lighter than anything offered on the market today — cutting carbon emissions of any truck that is pulling a Wabash trailer.

"MITO's technology was developed to be a robust solution to usher in the next material evolution," commented Haley Marie Keith, CEO of MITO Material Solutions. "I believe the transportation market will be critical to this next phase of our company's commercial goals as well as allowing us to make a lasting impact on sustainability." CEP

Table 1. A comparison of properties of 12-in. by 12-in. fiber-reinforced composite test panels impregnated with MITO vs. nanosilica additives.

Attribute	MITO	Nanosilica
Integration Time	1–2 min	30–60 min
Additional Weight	0.008 lb	3.2 lb
Flex Strength Increase	55%	30%
Interlaminar Fracture Toughness Increase	50%	40%

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