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NEWSLETTER

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Many Ways Lead to Rome – How Industry is Improving the Recyclability of Composites

For decades engineers have been increasingly using thermoset matrix materials such as GF/CF-reinforces epoxies for high demanding applications, (e.g., from wind turbines to structural parts of aircraft, such as fuselage and wings, or high-performance automotive components) owing to their outstanding mechanical properties, good fatigue and creep resistances, and ease of production. Nevertheless, these excellent engineering materials raise a major issue regarding their recyclability as they are intrinsically insoluble and infusible. However, in the age of sustainability and circularity, repurposing, and reusing composites at the end of their use life has become imperative since the incineration or landfilling of composite materials is neither societally acceptable nor legally permitted (landfilling) in some European countries.

The composite industry is developing multiple technologies to extract higher value out of end-of-use-life composites. One of the challenges of the recycling process consists in the efficient separation of the reinforcement fibers from the polymer matrix. This is particularly important for CF-composites since the carbon fibers technical properties represents a high value and should only be diminished as little as possible by the recycling process.

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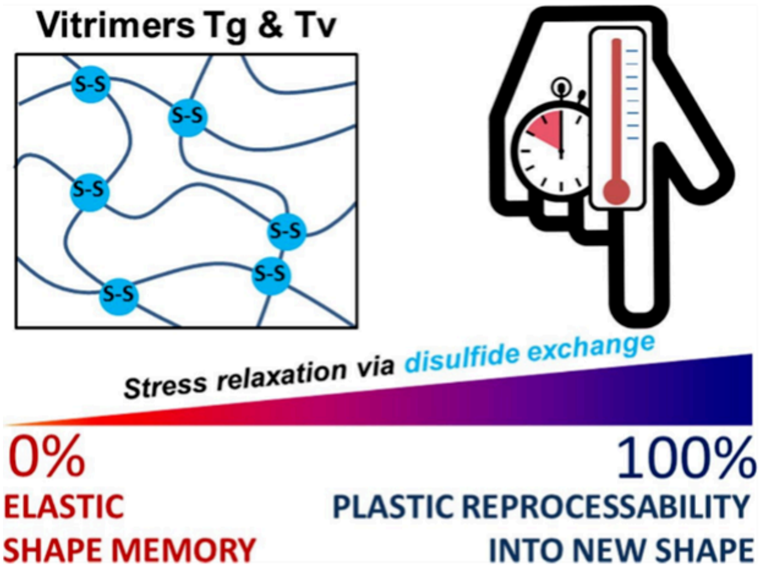
One option, the so-called cement co-processing, is reusing the silicate in glass fibers to build cement clinker while the epoxy polymer matrix is serving as fuel source, thus helping to lower the carbon footprint of cement production by replacing high-carbon intensity fuels such as lignite (brown coal) or pet coke. This option is available across Europe at an industrial scale, has a high degree of Technology Readiness Level (TRL) scale and can absorb large quantities of composite waste. Thus, cement co-processing is an immediate solution for a growing composite waste problem.

Pyrolysis and Solvolysis are two alternative technologies which seek to extract further value from composite waste by making the fibers reusable in composite manufacturing. Various types of pyrolysis techniques do exist, but the basic principle is the cracking of the polymer matrix at high temperatures (450 - 550 ^{0}C) in the absence of oxygen. The output materials are GF/CF fibers, pyrolysis oil, which can be sent to a cracker to make new chemical building blocks, and pyrolysis gas which usually serves to fuel the decomposition process.

Solvolysis is employing pressure, temperature, and chemicals (alcohols and glycols) or sub/supercritical water in the presence of catalysts (acid and base) for "disassembly" of the reinforced composite, which can yield cleaner fibers compared to pyrolysis while dissolving the polymer matrix in the process. Both degradation components, after further processing, can be fed back into the composite manufacturing process.

Whilst pyrolysis is already employed by industry at a smaller industrial scale, solvolysis processes have not moved beyond the lab or pilot plant scale.



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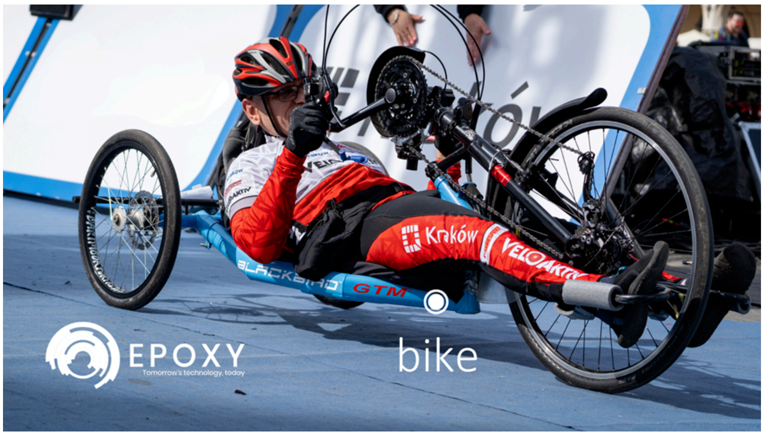
A further option, which could be considered technically more sophisticated, is the integration of recyclability into one the building blocks of the epoxy matrix. This is achieved by modifying the structure of the hardener components so the breakage of thermoset cross-links can be triggered by thermal or pH load.

Another interesting technology is the development of vitrimer chemistries in composite materials. They are a new type of polymeric material based on associative covalent adaptable networks (CANs). The crosslinks are constituted of reversible chemical reactions based on associative exchange mechanisms which make thermosets with good mechanical integrity combined with thermoplastic-like behavior at high temperatures. This technology can impart healability, reprocessability and recyclability to composites, but has not moved beyond lab stage yet.

OLYMPICS CAMPAIGN

Our recent LinkedIn campaign highlighted how epoxies enhance sports performance, as seen this summer at the Olympic Games. From stronger stadiums and durable sports gear to innovative surfaces, epoxy technology is crucial in making sports safer and more exciting. With epoxy, athletes can reach new heights in performance while fans enjoy a better overall experience. #EpoxyForSports



EPOXIES AND WIND EUROPE

In this featured video, we explore the pivotal role epoxy resins play in advancing Europe's wind energy sector. With cutting-edge applications in the construction of wind turbine blades, epoxies provide the strength, durability, and lightweight characteristics essential for optimizing efficiency. The video showcases key partnerships and innovations, demonstrating how epoxy technology is fuelling a greener future for Europe.

From enhancing energy production to supporting long-term sustainability goals, epoxy resins are truly at the heart of Europe's renewable energy revolution.

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