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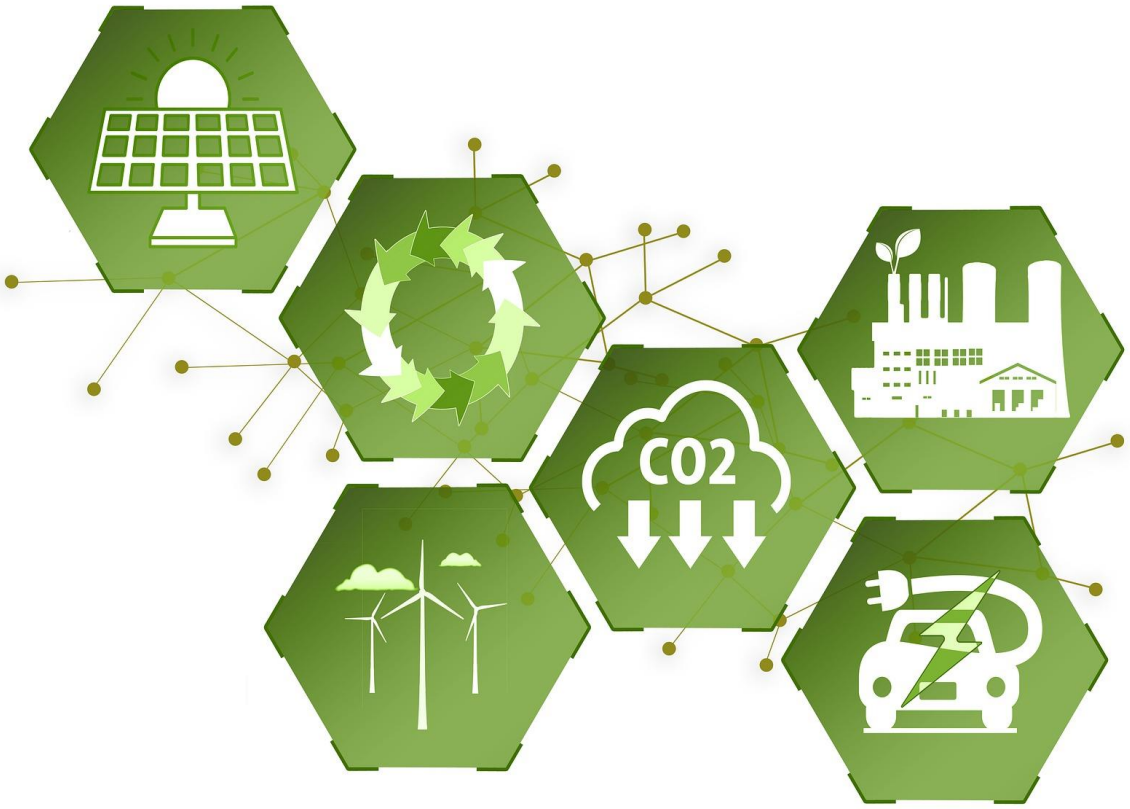


World Pultrusion Conference 2022 highlights composites sustainability

European Pultrusion Technology Association

EPTA EUROPEAN PULTRUSION TECHNOLOGY ASSOCIATION

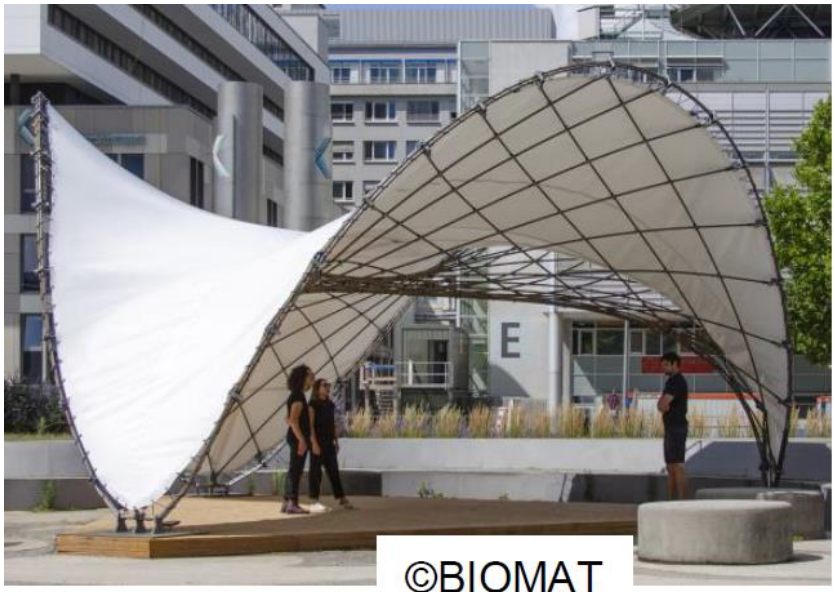
More than 130 professionals from the global pultrusion community gathered at the 16th World Pultrusion Conference in Paris on 5-6 May 2022. The conference is organised by the European Pultrusion Technology Association (EPTA) in collaboration with the American Composites Manufacturers Association (ACMA) and takes place every two years. A packed programme offered delegates the opportunity to learn from more than 25 international speakers sharing the latest information on market trends, developments in materials, processing and simulation technologies, and innovative pultruded applications in key markets such as building and infrastructure, transportation and wind energy. The final session of the event highlighted *Sustainability & Recycling Solutions*, with talks exploring the use of bio-based materials in pultrusion, applications for recycled carbon fibre, the outlook for composites circularity, and the importance of improving sustainability throughout the value chain.

Progress in 'bio-pultrusion'

Professor Markus Milwich from the German Institutes for Textile and Fiber Research Denkendorf (DITF) kicked off the session with his presentation *Pultrusion process for sustainable bio-based epoxy and natural fibre composites.*

DITF Denkendorf was established in 1931 to research on natural and celluslose based fibres as native alternatives to cotton and wool. Today, its application-oriented research encompasses the entire textile value chain 'from molecule to product.' The manufacture of more sustainable composites combining natural or cellulosic fibres and bio-based resins is one area of focus.

Composites based on cellulosic fibres and naturals fibres like hemp, flax hop (and others) offer a number of benefits, including lower density and high specific strength comparable to glass fibre composites, greater vibration damping than glass and carbon fibre composites, heat insulation and high impact strength. Milwich introduced a selection of collaborative projects investigating pultrusion with natural/cellulosic fibres and bio-based resins.



Natural fibre composites can offer a more sustainable material for architectural projects.

The BioMat Pavilion inaugurated on the University of Stuttgart campus in 2021 is described as an active-bending structure fabricated from natural fibres. The lightweight structure combines 'bamboo-like' natural fibre-based pultruded profiles with a tensile membrane. In this project, DITF collaborated with the university's Department of Biobased Materials and Materials Cycles in Architecture (BioMat) group and other partners to produce hollow profiles based on flax and hemp fibres and a standard epoxy resin as well as a bio-epoxy resin.

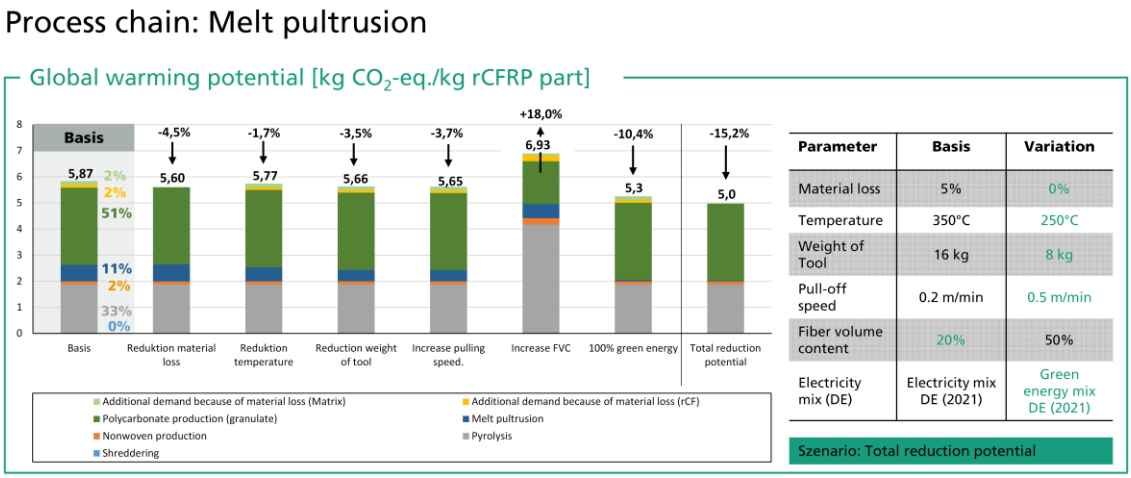
DITF is also part of a project to develop a pultruded façade profile from regenerated cellulose filaments and a bio-resin system based on epoxidised linseed (vegetable) oil, while the PULaCell project is developing bio-based cellulose fibre-reinforced biobased polyurethane profiles designed to strengthen wood construction materials. German company Manaomea is pultruding parts for custom-made furniture using discarded textiles, natural fibres and a self-developed bio-based resin.

When does it make sense to use recycled carbon fibre?

The use of recycled carbon fibre (rCF) materials in carbon fibre reinforced plastic (CFRP) components has the potential to reduce their cost and carbon footprint. However, it is currently only used to a limited extent since manufacturers are uncertain about the technical performance of available rCF products, how to process them, and the actual benefits achievable. Therefore, it is necessary to investigate under which conditions the use of rCF makes sense from a technical, environmental and economic point of view. Kerstin Angerer from the Fraunhofer Institute for Casting, Composite and Processing Technology IGCV discussed a project which addresses these challenges in her presentation *Recycling of CFRP – an approach from a technical, ecological and economic perspective*.

Fraunhofer IGCV is partnering with the Institute for Textile Technology (ITA) Augsburg in the two-year MAI ÖkoCaP project funded by the German Federal Ministry for Economic Affairs and Climate Action. The objective is to establish a reliable and transparent basis for decision making which allows the benefits of using rCF in different industrial applications to be estimated. At the end of the project (March 2023), the results will be summarised in a guide and made available in a web-based app so that small- and medium-sized companies will be able to make decisions about using rCF without having to invest significant resources into familiarising themselves with this complex subject.

To establish a sound basis for evaluating the ecological, economic and functional benefits of rCF a broad base of high-quality data is required. The project will consider a number of material- and process-related variables and their relationship with component quality, environmental impact and product costs. The project's scope includes: matrix (thermoplastic and thermoset); fibre (pyrolysed carbon fibre, dry production waste); nonwoven production (carding, wet-laid, airlaid); further processing (organosheet production); part production (wet compression moulding, nonwoven melt pultrusion, vacuum assisted resin infusion.) Data collection and technical analysis will be followed by multi-critical evaluation of several process steps and process chains.



Global warming potential calculation per 1 kg rCFRP component (1.5 m long, 0.03 m wide, 2.3 mm thick) produced by melt pultrusion. (Source: Fraunhofer IGCV.)

Angerer presented global warming potential (GWP) calculations for the manufacture of a rCFRP part combining a rCF nonwoven with polycarbonate (PC) resin using the melt pultrusion process. The analysis considered fibre matrix separation (shredding and pyrolysis), nonwoven production (carding) and part production (melt pultrusion). It was found that the GWP of the overall process chain is dominated by the production of PC granulate and the pyrolysis process; the melt pultrusion step has a limited effect. However, the GWP of the melt pultrusion stage itself can potentially be reduced by 15% by altering various parameters (such as reducing temperature and tool weight, increasing productivity, and switching to green energy). In most cases, reduced GWP also resulted in lower costs. The exception was the use of 100% green energy, which increased costs.

Circularity and recycling

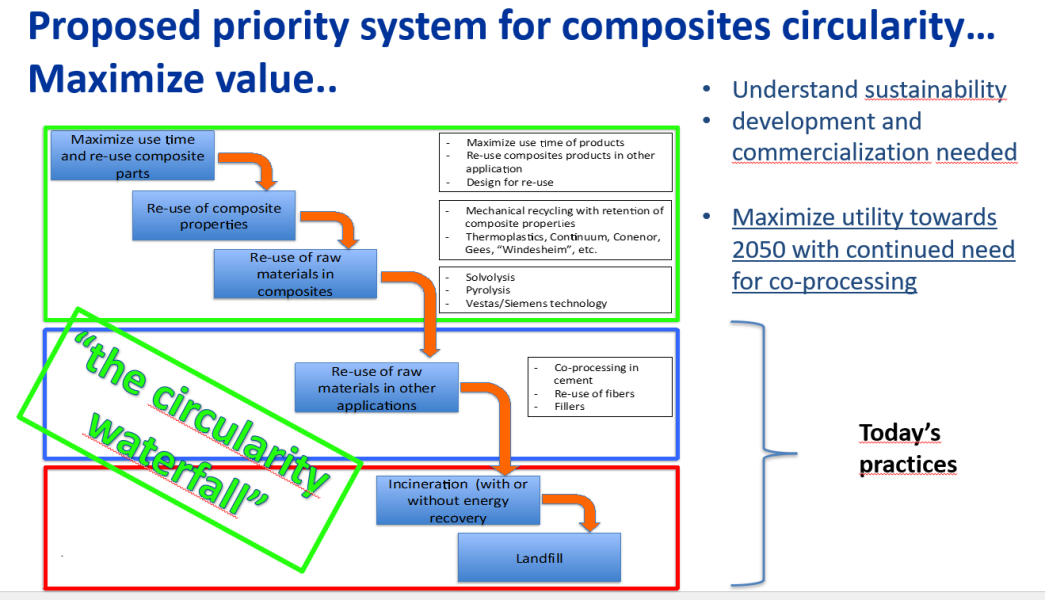
Circularity will be a future requirement for all materials, although the approach may differ for different markets. The European Composites Industry Association (EuCIA) is working with the composites industry, OEMs and other stakeholders to ensure that composites are becoming truly circular, with the aim of demonstrating this to the EU Commission. It is currently drafting a circularity roadmap for the composites industry.

In his presentation *Recycling of composites: The cement kiln route – a cornerstone for circularity*, Dr. Jaap van der Woude, chairman of EuCIA's Sustainability Working Group, reviewed the definitions of composites recycling and composites circularity. *Composites recycling* involves the conversion of waste composite materials into new materials and objects, not necessarily for the manufacture of new composite products, enabling reduction of resource depletion. *Composites circularity* is the conversion of composite waste into new materials and objects specifically for the manufacture of new composite products, enabling reduction of resource depletion *and* retention of the intrinsic value associated with composite properties.

He went on to explain that co-processing of glass fibre thermoset composite waste in cement kilns *is* recycling. This solution is fully compliant with the EU's Waste Framework Directive and in commercial operation at industrial scale in Germany. EuCIA collaborated with the European Cement Association (CEMBUREAU) on a position paper for the EU Commission's Joint Research Centre (JRC) which outlines the benefits of co-processing end-of-life composites in cement manufacturing.

Co-processing is seen as a main pathway for reduction of CO_2 intensity in cement manufacturing and an essential element in the cement sector's vision of achieving carbon neutrality by 2050. When ground composites waste is employed in co-processing the glass fibre is used as a raw material in the manufacture of the cement clinker, and the polymer matrix is burned as fuel for the process. This reduces both the use of natural raw materials and fossil energy sources. Initial studies have indicated that co-processing with composites has the potential to reduce the global warming impact of cement manufacture by up to 16%, but updated data and a better understanding of the full life cycle assessment (LCA) of the process is needed. Ways to separate carbon and glass fibre waste and combine glass fibre composite waste streams to provide increased volumes for cement manufacturing are also required.

Van der Woude continued by discussing technologies in development to allow recovery of fibre and/or resin from composites, such as solvolysis, pyrolysis and chemical recycling, but emphasised the LCA (energy demand) of these processes needs to be better understood. He introduced the 'circularity waterfall,' a proposed priority system for composites circularity, which highlights the continued need for co-processing. EuCIA believes that composites recycling is an integral part of the life cycle of composite parts and the cement kiln route is, and will remain, a cornerstone for the composite industry's long-term circularity strategy.



The 'circularity waterfall' for composite materials. (Source: EuCIA.)

EuCIA is calling on the composites industry to fully commit to seeking and supporting commercially- and environmentally-viable circular solutions for composites waste, which are proven by LCA data and acceptable to the EU Commission and other governing bodies. It is collaborating with WindEurope, Cefic (the European Chemical Industry Council), European Boating Industry (EBI) and other stakeholders in several cross-sector initiatives to advance novel approaches.

Working together

In the final talk of the conference, *Keen to be green – working together as the composites industry*, Thomas Wegman, Marketing Manager EMEA at resins manufacturer AOC, discussed how sustainability is essential for long-term viability of business operations along the entire value chain to ensure the health and safety of staff, minimise waste generation and greenhouse gas (GHG) emissions, and reduce costs. The company's actions to improve sustainability include programmes to reduce energy, waste and GHG emissions from AOC operations, the development of 'greener' and low VOC emission resins, ensuring compliance with chemicals legislation such as REACH, and involvement in EuCIA's waste management initiatives.

At AOC's Filago plant, audits, monitoring programmes and investigations by a dedicated project team identified various ways to reduce energy consumption and associated CO_2 emissions. (Image @ AOC.)

AOC's Next™ brand of sustainable resins includes products that help to reduce VOC emissions, including styrene-free and low-styrene formulations, and resins manufactured using bio-based raw materials and recycled PET (rPET). Increased use of bio-based resins reduces dependence on fossil-based raw materials and offers opportunities to improve supply security and (in some cases) performance. The use of bio-based materials sometimes results in a lower environmental footprint, but not always, Wegman notes, and in AOC's experience customers appreciate better performance but are reluctant to pay only for a 'bio feature.'

AOC has also been developing resins based on rPET and Wegman highlighted the opportunity for Europe to make better use of this valuable resource for making synthetic resins. Use of rPET in resin formulations improves material circularity and reduces consumption of virgin material (with associated reductions in energy and GHG emissions), whilst meeting performance requirements of customers.

He went on to discuss potential changes to the styrene occupational exposure limit (OEL) in Europe. At present styrene OELs differ between EU member states, ranging from 0 ppm to 100 ppm, with 20 ppm being the most common. The EU Commission and ECHA (European Chemicals Agency) have been discussing a single, EU-wide OEL for styrene. Cefic is conducting a survey of unsaturated polyester and vinyl ester resin industrial use across the EU to identify areas where customer support may be required.

Wegman concluded with an overview of AOC's participation in EuCIA's sustainability group, which is working to estimate composite waste streams across different markets and applications, understand differences in waste management legislation across Europe, and identify technologies for composites recycling which make better use of composite material benefits at affordable cost. He discussed some of the options, and challenges, for end-of-life recycling and echoed van der Woude's statement on the need for better understanding of the LCA impact of the various technologies under development.

Supporting growth

"From new materials, processing technologies and simulation techniques, to innovative applications such as automotive battery covers, smart air cargo containers and bendable rebars … this year's conference showcased the pultrusion industry's continued focus on improving performance and productivity," comments Dr Elmar Witten, Secretary, EPTA. "Solutions to advance recycling and circularity of composites will also be key to ensuring the sustainability, future growth and competitiveness of the pultrusion industry. We look forward to discussing further progress in all these areas at the North American Pultrusion Conference next year."

EPTA organises the World Pultrusion Conference in Europe every two years in collaboration with the American Composites Manufacturers Association (ACMA), which hosts the North American Pultrusion Conference in the intervening years. ●

About EPTA

Pultrusion is a continuous process for producing linear fibre reinforced plastic (FRP) profiles with a uniform cross-section. Since pultrusion allows for extremely high fibre loading and accurately-controlled resin content, pultruded parts have excellent structural properties and are produced at a consistently high quality. The European Pultrusion Technology Association (EPTA) was created in 1989 by a group of leading European pultruders with the mission of supporting the growth of the pultrusion industry by maximising external communication efforts and encouraging knowledge sharing between members. Since 2006, the association has existed under the umbrella of the AVK – Industrievereinigung Verstärkte Kunststoffe e.V., in Frankfurt, Germany.