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Image: Dorset, UK based Norco Composites has made three 14 m long canopies using Scott Bader's Crystic resin VE679-03PA and gelcoat GT600. The resin helped create a glass fiber composite laminate with a closed cell structural foam core to provide adequate panel stiffness over the large hollow wing shape. The project called for Norco to build the canopies to look like polished metal features, while being lightweight and robust enough to withstand the harsh environmental conditions.

REINFORCED *plastics*

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RP Rewind

Liz Nickels leafs through past issues of Reinforced Plastics to find out what was happening in the RP industry of the past.

Five years ago...

Composites Europe reached its ninth year, attracting around 440 exhibitors from 25 countries. More recently in 2017 the company welcomed 406 exhibitors from 28 countries and 8,342 visitors, falling just short of 2016 where there were 8,622, but received a large number of visitors from outside Germany – more than 40% – including from Brazil, the US and Canada, and Japan, New Zealand and South Africa.

There was news this month that Northrop Grumman Corporation, Scaled Composites and Virgin Galactic were developing a preliminary design and flight demonstration plan for the Defense Advanced Research Projects Agency (DARPA)'s Experimental Spaceplane XS-1 program. According to Wikipedia, work is still ongoing on the Spaceplane, with DARPA beginning Phase 2 of the XS-1 program in April 2016. In May 2017, the agency selected Boeing for Phase 2/3 to build and test the XS-1 (now called the Experimental Spaceplane program). The first XS-1 orbital mission could reportedly happen occur in 2020.

10 years ago...

James Malcolm, business development engineer at Belzona Polymerics Ltd, discussed the use of composites technology in the repair of steel pipes. 'For years the only credible solutions to damaged pipe-work were to cut out the section and



Ten years ago the magazine discussed the use of composites technology in the repair of steel pipes.

replace it with new or welding sections, usually stopping production,' he said. 'In addition, the hot work required to complete the replacement prohibits use in many sensitive environments and the metallurgical problems caused by welding often add up to a costly, complicated solution'.

'As the pressures placed on pipe maintenance engineers have increased so has the use of mechanical clamps and composites. Composite repairs have become increasingly popular as an alternative to replacement, and particularly mechanical clamps, as they offer

increased versatility, can be used in areas where clamps cannot and are often more cost effective.'

20 years ago...

Calling it a 'virtual laboratory' for composites, the magazine reported on one of the first pieces of software designed specifically to help improve composite quality. Originally developed for the US Air Force to identify the cause of failure of composite aircraft components, V-Lab was now available on commercial release and enabled the user to perform analysis, numerical experimentation and design prototyping using advanced composite stress and failure analysis tools. The US \$1500 software was designed to be easy to use by designers who were relatively new to composite materials and structural analysis.

The future was also calling with news this month of how companies were focusing on the development of alternative fuel vehicles. 'The inherent design flexibility of composites is playing an integral role in production of bodywork, and structural parts, for these zero emission vehicles,' we said. Flash forward to 2018, and the use of composites – especially their lightweight aspect – has played a major part in the successful launch of several electric cars to the market.

1369-7021/<https://doi.org/10.1016/j.repl.2018.08.049>



Applications

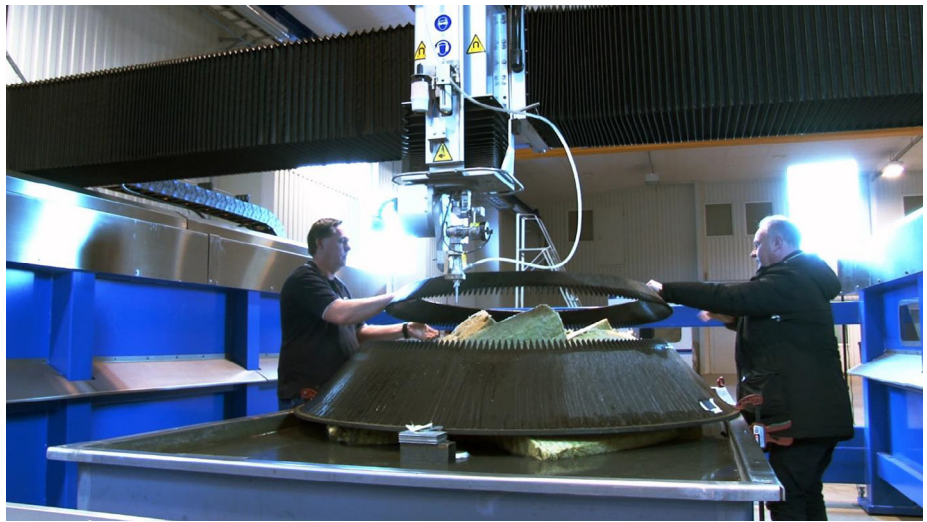
Carbon fiber in space

A Swedish supplier of payload adapters and separation systems for commercial space launch vehicles has recently developed payload adapter systems made of 100% carbon fiber.

The purpose of the two systems is to bring a satellite into orbit, ensuring that satellite and rocket remain securely attached to one another during the journey into space, and then deliver the payloads into orbit with precision.

Current payload adaptors are made of aluminum and carbon fiber technology bolted together into a cone, several meters in diameter. While over 600 separations have been carried out in orbit with a 100% success rate, calculations have shown that payload adapter systems in 100% carbon fiber could improve weight and stiffness. Instead of bolting the two Payload Adapter pieces together finger joints could also be used.

In tests, the carbon fiber was cut into 47 mm long finger joints in a cone shaped 12 mm thick with a circumference of 7.2 m using FiveX waterjet technology from Water Jet Sweden. The incision reportedly needed a tolerance of 0.1 mm



The carbon fiber was cut into 47 mm long finger joints in a cone shaped 12 mm thick.

around the circle, to be able to safely be glued together.

‘Our FiveX machine system is unique since it has a combination of extreme precision and a full 3D abrasive cutting ability,’ said Tony Ryd, CTO at Water Jet Sweden. ‘It is specially designed for this kind of advanced applications,

cutting with a repetition accuracy of ± 0.025 mm.’

Water Jet Sweden;

www.waterjetsweden.com

0034-3617/<https://doi.org/10.1016/j.repl.2018.08.018>

Stiff glass fiber improves surgery tools

Solvay says that its Ixef polyarylamide (PARA) resin was used in the development of a compression staple system, a single-use bone staple kit for orthopedic procedures targeting the hand and foot.

The kit comprises a disposable sterile surgical tool set for fixating hand and foot bone fragments, osteotomy fixation and joint arthrodesis. It makes use of Solvay’s

Ixef GS-1022 PARA, 50% glass fiber-reinforced grade, for several components: the implant sizer, the drill guide and each part of the implant delivery instrument, including its handle, the saddle on which the staple sits, and the threaded compressor that forces the staples fully open.

The mechanical strain on these components requires them to be molded

from a very high-stiffness material. Solvay says that the grade used offers metal-like strength, rigidity and dimensional stability and is suitable for sterilization using high-energy gamma radiation. The material has been evaluated for ISO 10993 limited duration biocompatibility and is supported by an FDA Master Access File.



Applications

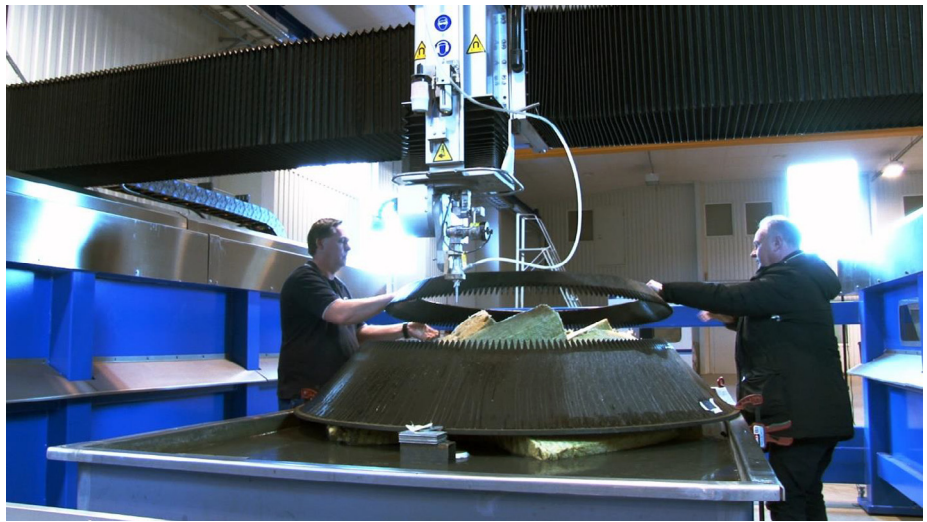
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More robust

'Our impetus for this kit was to develop a more robust, single-use bone fixation system than currently available,' said Daniel Lanois, the development engineer for the system at Reign Medical. 'Many competitive solutions use lower performing plastics that do not reliably withstand the force required to hold Nitinol staples open, causing the staples to disengage prematurely. After briefly considering polycarbonate and ABS blends, we chose Ixef PARA primarily for its outstanding stiffness, which enabled even the smaller components of the delivery tool to reliably withstand the compression of the staples as well as the torsional, tamping



The kit comprises a disposable sterile surgical tool set for fixating hand and foot bone fragments, osteotomy fixation and joint arthrodesis.

and axial loads applied during fixation procedures.'

Solvay; www.solvay.com

0034-3617/<https://doi.org/10.1016/j.repl.2018.08.017>

Tough composites for space programs

Composites specialist Solvay has signed a new agreement to supply Swiss aerospace company RUAG with structural composites for US and European space launcher programs.

Solvay will supply its MTM 46 composite products for RUAG to make large integrated structural components including payload fairings, stage and payload adapters, dispensers and separation systems on next-generation launchers. MTM 46 is an out-of-autoclave toughened epoxy resin system that meets space agencies requirements and can be used in light and stiff sandwich structures. According to Solvay, it has been specifically developed for extremely demanding applications such as space programs.

'RUAG Space is the leading supplier of composite payload fairings and is an expert in out-of-autoclave manufacture,' said Marc Doyle, executive vice-president at Solvay. 'We look forward to supporting RUAG's operations out of Decatur, Alabama, USA and Emmen, Switzerland



From left to right: Hannes Schuette, account manager, Solvay, Marc Doyle, executive vice-president, Solvay, Stefan Hofmann, manager at RUAG, and Jan Imbusch, also a manager at RUAG.

as they further contribute to space transportation.'

Solvay; www.solvay.com

0034-3617/<https://doi.org/10.1016/j.repl.2018.08.016>

Composite adhesives approved for yacht manufacture

Scigrip says that its composite bonding products have been used by Italian yacht manufacturer Ferretti.

Ferretti and Scigrip distributor Mastikol investigated replacing classic polyester-

based adhesives with Scigrip's methacrylate adhesives to bond a glass fiber hull shell and the structural elements, specifically those of the engine room and other key load bearing parts,

that are laminated off-line and built off-site.

Mastikol used Scigrip's Lloyd's approved SG230 HVA adhesive, supplied in 189 litre drums. This high viscosity,

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thixotropic adhesive can also be applied in void free bead sizes up to 80 mm. Different hardener speeds were supplied allowing customised working times to match the required joining times. Given the large bonding surface area, it was necessary to use an application system that dispenses a large quantity of product in the shortest possible time. Mastikol and Scigrip also specified a special drum extruder to dispense the product.

The companies sat that they are looking to further improving the production process in the future, which could reduce the surface preparation stage and make use of the adhesive's capacity to adhere to smooth, gel-coated and moist surfaces, reducing production cycle time and dust.

Scigrip; www.scigrip.com

0034-3617/<https://doi.org/10.1016/j.repl.2018.08.015>

Rhode Island focuses on glass fiber recycling

The Rhode Island Marine Trade's Association (RIMTA) Foundation has launched the Rhode Island Fiberglass Vessel Recycling Project to look into the dismantling and re-processing of glass fiber hulls into cement as an alternative to landfill.

RIMTA says that between 2003 and 2012 it around two million recreational craft (an average of 210,000 per year) were retired in the US, according to surveys by the National Marine Manufacturers Association. While members of the European boating industry suggest that coastal nations in the EU retire between 6000 and 9000 recreational vessels annually. According to the association, some craft will be crushed and buried in landfills, while others may be abandoned by their owners on land or

in coastal areas where they can potentially harm the natural ecosystem.

The project aims to:

- Pilot the dismantling and processing activities of 60–100 metric tons of glass fiber vessels in partnership with local boatyards
- Partner with local, state, and federal agencies to design the process to meet all health and safety requirements
- Conduct an economic analysis of the pilot program to determine long-term feasibility
- Investigate legislation and regulations necessary to support fiberglass hull recycling
- Document lessons learned and develop resources to aid in glass fiber vessel recycling programs throughout the US and globally.



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RIMTA; www.rimta.org

0034-3617/<https://doi.org/10.1016/j.repl.2018.08.014>

Composite canopies look like metal

Dorset, UK based Norco composites have made three 14 m long canopies using Scott

Bader's Crystic resin VE679-03PA and gel-coat GT600. The resin helped create a glass

fiber composite laminate with a closed cell structural foam core to provide adequate



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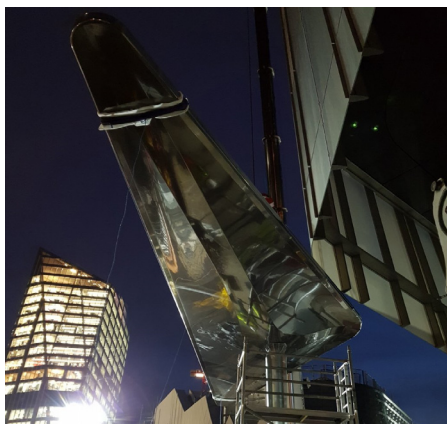
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The project called for Norco to build the canopies to look like polished metal features, while being light-weight and robust enough to with-stand the harsh environmental conditions.

A resin infusion process was adopted to produce the composite panels along with a staged infusion approach for the manufacture of the metal coated areas, in order to avoid 'print through' of the composite materials onto the external surface. Scott Bader's grey Crystic gelcoat GT600 RAL 2043 was then used as a



The finished glass fiber reinforced resin canopies.

the canopies to help ensure a consistent metal finish.

The canopies will be installed as part of the One Blackfriars development in London, UK, consisting of a 52-storey tower of a maximum height of 170 m and two smaller buildings of six and four storeys respectively. It includes residential flats, a hotel and retail units, along with a public space.

Scott Bader; www.scottbader.com

0034-3617/<https://doi.org/10.1016/j.repl.2018.08.013>

Composites contribute to lightweighting

Kordsa presented its composite technologies for lightening vehicles at the Michelin Movin' On Conference, which took place in Montreal, Canada.

The company's presentation covered the differences its technologies could make in mobility.

The Movin' On Conference, organized with the goal of 'living a global, smart, sustainable and multi-model mobility,' aims

to find sustainable solutions to the challenges of moving people and goods from one place to another. During the conference, more than 4000 participants from 31 countries came together and over 70 speakers made presentations, panels, roundtable meetings and practical workshops.

Kordsa says that it emphasized the need to lighten vehicles for efficient and

sustainable mobility. The presentation also underlined the future of mobility, and its aim to reduce the rolling resistance to decrease the fuel consumption with its tire reinforcement technologies and lighten vehicles with its composite technologies.

Kordsa; www.kordsa.com

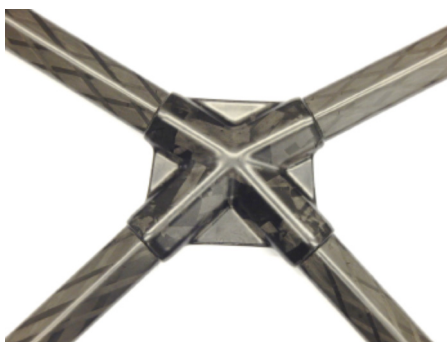
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Lightweight Audi part

A carbon fiber/epoxy molding compound from Hexcel has been used in a new overmolding process to produce a hybrid structure. The structure comprises Secar Technologies' pullwound carbon fiber sections and Hexcel's structural, rapid curing HexMC-i.

The two companies, along with Audi, joined forces to develop a composite engine bay brace for the Audi R8. This cross-shaped component braces the R8's mid-mounted V10 engine and provides increased torsional stiffness. The project's aim was to produce a composite version of the existing aluminum part that would offer improved light weighting as well as an improved visual appearance by providing a more organic molded shape.

For the R8 X-Brace, foam filled pull-winding carbon fiber tubes were produced and then overmolded with HexMC-i 2000 carbon fiber/epoxy molding compound to



This cross-shaped component braces the R8's mid-mounted V10 engine and provides increased torsional stiffness.

produce the central node and tube end terminations for direct mounting to the car.

The companies had to consolidate the molding compound and ensure the strongest adhesive bond with the thin walled (<1 mm wall thickness) carbon tubes without crushing the pre-cured elements.

Secar and Hexcel were also able to improve tool loading and press cure cycles to provide the best processing parameters for the compound with the M77 snap cure epoxy resin allowing a weight reduction of 15% over the previous aluminum version.

All metallic inserts for mounting the X-Brace were molded directly into the part during production, with the demolded part requiring minimal finishing before installation into the R8's engine bay.

In tests, the part showed a sufficiently strong bond to the pullwound tubes with no adhesive film or additional bonding material required between the tubes and the HexMC-i molding compound.

Hexcel;

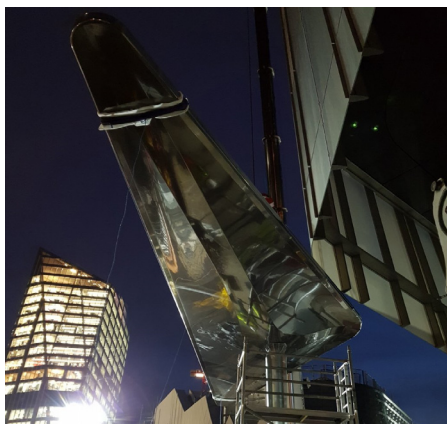
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panel stiffness over the large hollow wing shape.

The project called for Norco to build the canopies to look like polished metal features, while being light-weight and robust enough to with-stand the harsh environmental conditions.

A resin infusion process was adopted to produce the composite panels along with a staged infusion approach for the manufacture of the metal coated areas, in order to avoid 'print through' of the composite materials onto the external surface. Scott Bader's grey Crystic gelcoat GT600 RAL 2043 was then used as a



The finished glass fiber reinforced resin canopies.

the canopies to help ensure a consistent metal finish.

The canopies will be installed as part of the One Blackfriars development in London, UK, consisting of a 52-storey tower of a maximum height of 170 m and two smaller buildings of six and four storeys respectively. It includes residential flats, a hotel and retail units, along with a public space.

Scott Bader; www.scottbader.com

0034-3617/<https://doi.org/10.1016/j.repl.2018.08.013>

Composites contribute to lightweighting

Kordsa presented its composite technologies for lightening vehicles at the Michelin Movin' On Conference, which took place in Montreal, Canada.

The company's presentation covered the differences its technologies could make in mobility.

The Movin' On Conference, organized with the goal of 'living a global, smart, sustainable and multi-model mobility,' aims

to find sustainable solutions to the challenges of moving people and goods from one place to another. During the conference, more than 4000 participants from 31 countries came together and over 70 speakers made presentations, panels, roundtable meetings and practical workshops.

Kordsa says that it emphasized the need to lighten vehicles for efficient and

sustainable mobility. The presentation also underlined the future of mobility, and its aim to reduce the rolling resistance to decrease the fuel consumption with its tire reinforcement technologies and lighten vehicles with its composite technologies.

Kordsa; www.kordsa.com

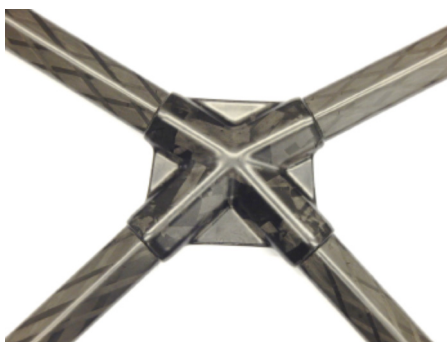
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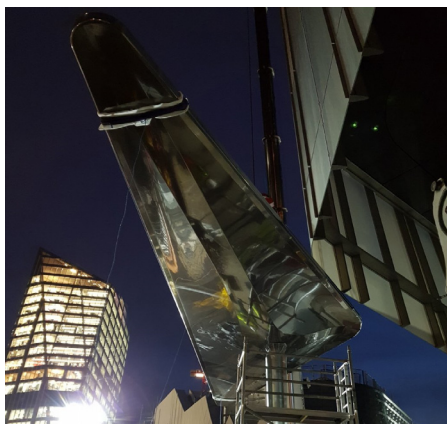
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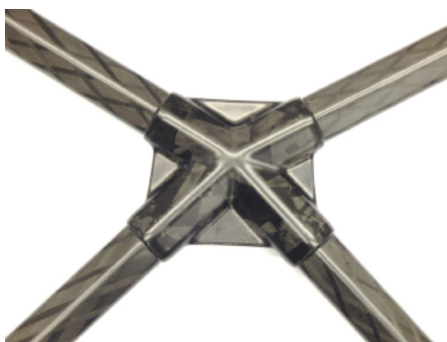
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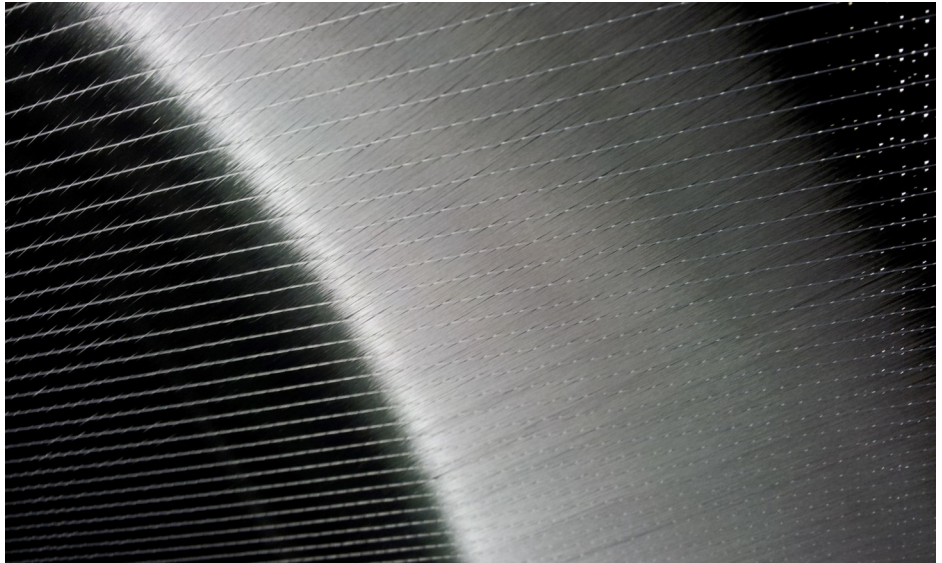
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Chomarat North America awarded aerospace certification

Chomarat's US facility, which specializes in composites reinforcements, has just been awarded AS 9100 certification. The new certification reportedly covers aerospace quality management systems and follows the group's development strategy with regards to quality and risk management. This follows the certification of the group's French plants that were certified to ES 9100 in 2012.

'Our North American plant's new AS 9100 certification proves our organisational maturity and provides a vital asset to enable us to become a leading aerospace supplier,' said Michel Cognet, group managing director at Chomarat.

Chomarat makes fabrics, tapes and multiaxial carbon reinforcements, including its C-PLY range, for the aerospace market. C-PLY was recently used by VX Aerospace for its foldaway drone, which can be stowed inside a cylindrical container and deployed from a tactical aircraft. The carbon multiaxial material is used in the con-



Chomarat makes fabrics, tapes and multiaxial carbon reinforcements, including its C-PLY range, for the aerospace market.

struction of the wing, the horizontal stabilizers, the vertical fin and all of the control surfaces.

Chomarat; www.chomarat.com

0034-3617/<https://doi.org/10.1016/j.repl.2018.08.010>



Business

Solvay and Airbus sign contract extension

Solvay and Airbus have reportedly sign a contract extension until 2025 for the supply of for composite and auxiliary materials. This contract extends the portfolio of products Solvay has supplied to Airbus to include primary and secondary structure in and out of autoclave cure prepreps for commercial aircraft and aerospace pro-

grams, adhesives and lightning strike protection materials for the A350 XWB as well as auxiliary materials and kits for the A350 XWB and a range of products sold to Airbus Group for helicopters, space and associated partner companies' applications.

'We believe this extended contract, by securing supply for key current

programs, will enable Solvay and Airbus to focus their efforts on future strategic collaborations,' said Carmelo Lo Faro, president of Solvay composite materials.

Solvay; www.solvay.com

0034-3617/<https://doi.org/10.1016/j.repl.2018.08.045>

Solvay targets Asia-Pacific

Composites supplier Argosy International Inc and Solvay's composite materials business have agreed to 'enable direct service' of Solvay materials in the Asia-Pacific region. The agreement also includes the purchase of some Argosy assets that will be used to service the region.

'Solvay and Argosy have worked together for many years to serve the Asia-

Pacific region,' said Carmelo Lo Faro, president of the composite materials business. 'With Solvay's acquisition of Cytec, and its legacy of strong presence in Asia Pacific, the opportunity to further improve our service to the region and its customer base was clear to both parties.'

'Going forward, Argosy will focus its efforts on growing its honeycomb and

coatings businesses,' said Paul Marks, CEO of the company. 'In addition, Argosy will be expanding through several new businesses which leverage Argosy's competencies'.

Solvay; www.solvay.com

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Solvay receives supplier of the year award

Solvay has received a supplier of the year award from Gulfstream Aerospace Corp. The company supplies the aircraft manufacturer with a range of composite materials, adhesive and surfacing films from its Anaheim CA, Greenville TX and Have de

Grace, MD sites. These products are used in the Gulfstream G500, G550, G600 and G650 programs.

'We look forward to an ongoing positive relationship with Gulfstream and its partners in the future,' said Marc

Doyle, executive vice president at Solvay.

Solvay; www.solvay.com

0034-3617/<https://doi.org/10.1016/j.repl.2018.08.043>

SGL Carbon increases graphite production

SGL Carbon, which makes carbon fiber and other materials, says that it has increased its capacities to make synthetic graphite anode material for lithium-ion batteries. The company is also investing in a battery application laboratory.

'The demand for high-performance lithium-ion batteries for electric vehicles and thus, high-quality synthetic graphite anode materials is constantly growing,'

said Dr Jürgen Köhler, CEO. 'In consideration of the growing number of projects in the field of electric mobility and the resulting demand for graphite anode materials for lithium-ion batteries, we are currently in an evaluation process of this very dynamic market to decide on potential capacity increases beyond the steps already taken.'

Synthetic graphite anode materials for lithium-ion batteries from SGL Carbon can be found in markets such as electric vehicles, stationary energy storage systems, and mobile end user devices.

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SGL Carbon finalizes rebranding



Dr. Jürgen Köhler, CEO of SGL Carbon.

SGL Carbon has developed a new company logo and changed its name from SGL Group – The Carbon Company.

‘With the completion of the strategic realignment, a new era begins for us as a company,’ said Dr. Jürgen Köhler, CEO. ‘Now is the right time to rethink and sharpen our profile. As a technology-based company it is our aspiration to develop smart solutions that deliver a clear benefit for our customers.’

The company says that the return to the name SGL Carbon expresses its ‘core expertise and origin’.

SGL has also launched a new website at

www.sgllcarbon.com.

0034-3617/<https://doi.org/10.1016/j.repl.2018.08.041>

Marine associations publish guide to workforce growth

The Marine Retailers Association of the Americas, the National Marine Manufacturers Association and the Rhode Island Marine Trades Association (RIMTA) have published a new guide entitled ‘10+1 Strategy: A Marine Industry Guide to Growing the Workforce’.

‘This comprehensive, 30-page document provides action-oriented, solution-

based approaches, in addition to myriad resources that we hope provide clear direction for the successful growth of our industry’s employers,’ said Matt Gruhn and Thom Dammrich, presidents of the MRAA and NMMA.

‘For boating to be successful in the economy, now and into the future, we

must build a workforce that will allow for growth, success and sustainability,’ said Wendy Mackie, CEO of RIMTA.

RIMTA;

www.rimta.org

0034-3617/<https://doi.org/10.1016/j.repl.2018.08.040>

Quickstep appoints new CFO

Quickstep Holdings Limited, an Australian manufacturer of carbon fiber composite components and assemblies, has appointed Alan Tilley as its new chief financial officer (CFO).

Tilley’s background includes executive roles with NRMA Motoring and Services Group, Brambles Industries Limited, Transfield Pty Ltd, Price Waterhouse and

more recently as interim CFO with Murray Goulburn.

Quickstep’s former CFO, Andrew Crane, who is departing the role for personal reasons, will remain in the business for a brief handover period.

‘We welcome Alan to Quickstep,’ said Mark Burgess, CEO. ‘We have spent the

past twelve months transitioning our business into one that is focused on accelerated growth and profitability.’

Quickstep Holdings;

www.quickstep.com.au

0034-3617/<https://doi.org/10.1016/j.repl.2018.08.039>

UK site of new prepreg facility

Composites Evolution has moved to a new prepreg manufacturing facility in Chesterfield, UK.

‘This exciting development of our business concludes several years of investment in product development and commercialisation,’ said Dr Brendon Weager, technical director. ‘Our production launch products include the Evopreg range of epoxy prepreps for both components and tooling, as well as the ground-breaking PFA-based Evopreg-PFC prepreps.’



The new prepreg line.

‘We are looking forward to welcoming our customers and supply partners to our new factory to discuss how we can work together to move their projects forward with both our pilot and large scale production facilities,’ added Gareth Davies, commercial manager.

Composites Evolution; www.compositevolution.com

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‘We are looking forward to welcoming our customers and supply partners to our new factory to discuss how we can work together to move their projects forward with both our pilot and large scale production facilities,’ added Gareth Davies, commercial manager.

Composites Evolution; www.compositesevolution.com

0034-3617/<https://doi.org/10.1016/j.repl.2018.08.038>

SGL Carbon finalizes rebranding



Dr. Jürgen Köhler, CEO of SGL Carbon.

SGL Carbon has developed a new company logo and changed its name from SGL Group – The Carbon Company.

‘With the completion of the strategic realignment, a new era begins for us as a company,’ said Dr. Jürgen Köhler, CEO. ‘Now is the right time to rethink and sharpen our profile. As a technology-based company it is our aspiration to develop smart solutions that deliver a clear benefit for our customers.’

The company says that the return to the name SGL Carbon expresses its ‘core expertise and origin’.

SGL has also launched a new website at

www.sglcarbon.com.

0034-3617/<https://doi.org/10.1016/j.repl.2018.08.041>

Marine associations publish guide to workforce growth

The Marine Retailers Association of the Americas, the National Marine Manufacturers Association and the Rhode Island Marine Trades Association (RIMTA) have published a new guide entitled ‘10+1 Strategy: A Marine Industry Guide to Growing the Workforce’.

‘This comprehensive, 30-page document provides action-oriented, solution-

based approaches, in addition to myriad resources that we hope provide clear direction for the successful growth of our industry’s employers,’ said Matt Gruhn and Thom Dammrich, presidents of the MRAA and NMMA.

‘For boating to be successful in the economy, now and into the future, we

must build a workforce that will allow for growth, success and sustainability,’ said Wendy Mackie, CEO of RIMTA.

RIMTA;

www.rimta.org

0034-3617/<https://doi.org/10.1016/j.repl.2018.08.040>

Quickstep appoints new CFO

Quickstep Holdings Limited, an Australian manufacturer of carbon fiber composite components and assemblies, has appointed Alan Tilley as its new chief financial officer (CFO).

Tilley’s background includes executive roles with NRMA Motoring and Services Group, Brambles Industries Limited, Transfield Pty Ltd, Price Waterhouse and

more recently as interim CFO with Murray Goulburn.

Quickstep’s former CFO, Andrew Crane, who is departing the role for personal reasons, will remain in the business for a brief handover period.

‘We welcome Alan to Quickstep,’ said Mark Burgess, CEO. ‘We have spent the

past twelve months transitioning our business into one that is focused on accelerated growth and profitability.’

Quickstep Holdings;

www.quickstep.com.au

0034-3617/<https://doi.org/10.1016/j.repl.2018.08.039>

UK site of new prepreg facility

Composites Evolution has moved to a new prepreg manufacturing facility in Chesterfield, UK.

‘This exciting development of our business concludes several years of investment in product development and commercialisation,’ said Dr Brendon Weager, technical director. ‘Our production launch products include the Evopreg range of epoxy prepregs for both components and tooling, as well as the ground-breaking PFA-based Evopreg-PFC prepregs.’



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Owens Corning wins sustainability awards

Owens Corning says that it has been recognized as one of the world's most sustainable companies for the fifth consecutive year by sustainability investment specialist RobecoSAM. This recognition earned the company placement in RobecoSAM's 2018 Sustainability Yearbook which lists the world's most sustainable companies in each industry as determined by their score in RobecoSAM's annual Corporate

Sustainability Assessment. Firms were evaluated against a range of economic, environmental and social criteria.

RobecoSAM also named Owens Corning the building products industry leader with regards to materiality, climate strategy, recycling strategy, water-related risks and labor practices indicators.

Owens Corning has also been given a spot on the Supplier Engagement Leader

Board by CDP, a non-profit global environmental disclosure platform. This recognition means that the company has been identified as a global leader for its actions and strategies to manage carbon and climate change across its global supply chain.

Owens Corning; www.owenscorning.com

0034-3617/<https://doi.org/10.1016/j.repl.2018.08.037>

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JEC; www.jecgroup.com

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Lanxess makes new appointments

Specialty chemicals group Lanxess has appointed Jacques Perez as its new country representative of in the United Kingdom and managing director of Lanxess Holding UK. Born in France, Perez has been country representative and managing director of the company's Indian office since May 2014.

Lanxess has approximately 350 employees in the UK, with five production sites in Baxenden, Branston, Deeside, Sudbury and Trafford Park, Manchester.

Perez follows Kim O'Connor, who will retire on 31 October 2018 after more than 40 years with Lanxess and Bayer.

'On behalf of the entire board of management, I would like to thank Kim O'Connor for his excellent work and his outstanding contribution to the company over the years,' said Rainier van Roessel, Lanxess board member. 'At the same time I would like to wish Jacques Perez every success in his new role.'

The company has also appointed Frederique van Baarle as head of its

procurement and logistics group. Van Baarle is currently head of a marketing and sales engineering segment. She succeeds Bernd Makowka, who is retiring after 33 years at Lanxess and Bayer AG.

Van Baarle began her professional career in the chemical industry at Royal DSM and joined Lanxess in 2011.

Lanxess; www.lanxess.co.uk

0034-3617/<https://doi.org/10.1016/j.repl.2018.08.035>

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Specialty chemicals company Lanxess plans to open a new applications development and technical services laboratory for polyurethane dispersions (PUDs) in Latina, Italy. The new lab will operate as a standalone facility dedicated to PUDs as part of the company's existing urethane systems lab.

Lanxess says that the new lab will cover glass fiber sizing, coatings and adhesives applications in leather and textile finishing, and plastic, glass and metal substrates coatings.

'There is a growing demand from customers for VOC (volatile organic compounds) free and lower carbon footprint

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Lanxess; www.lanxess.com

0034-3617/<https://doi.org/10.1016/j.repl.2018.08.034>

Price adjustment for Lanxess compounds



Durethan engineering plastics (PA 6 and PA 6.6 compounds) are used in numerous applications. (Photo courtesy Lanxess AG.)

Lanxess says that it is raising its prices for Durethan A (polyamide 6.6) compounds in Europe, Middle East and Africa by EUR 0.60/kg with immediate effect.

'The overall tight market situation with extremely limited availability of raw materials in the PA 6.6 value chain has led to further severe price increases for PA 6.6 base resin,' the company said in a press release. 'As there are no signs of a relief, a price adjustment is unavoidable.'

Lanxess added that its materials business unit will offer support in exploring opportunities to replace PA 6.6 applications by PA 6 or PBT grades.

Lanxess;
www.lanxess.com

0034-3617/<https://doi.org/10.1016/j.repl.2018.08.033>

Kordsa among best employers in Brazil for third consecutive year

Turkish composites company Kordsa's facility in Brazil has been listed among the best employers in Brazil for the third time, by the Great Place to Work Institute (GPTW). Kordsa was ranked in fourth place and was the only industrial company to be included in the list.

'This recognition is an output of the steps we take towards becoming a global employer brand,' said Kordsa CEO, Ali Çal şkan. 'We see our human resources as our greatest asset. [...] With this understanding, we encourage our employees to be inspired from each other and inspire each other, care about their

own development, and live a balanced, happy life.'

Great Place to Work focuses on improving workplace culture and strategic organizational culture, focusing on employees.

Kordsa; www.kordsa.com

0034-3617/<https://doi.org/10.1016/j.repl.2018.08.032>

Composite facility certified for aerospace and defense

Reinforcement specialist Kordsa says that its composite manufacturing facility has received BS EN ISO 9001:2015 and EN 9100:2016 (AS9100D) international certification for quality and risk management in aerospace and defense industry.

The facility is located at the Composite Technologies Center of Excellence, at Sabanc University, Istanbul, Turkey and carries out research, technology and product development, entrepreneurship and production processes in composites

technologies. It is now compliant with Aerospace and Defense Industry Quality and Risk Management Standards.

Kordsa; www.kordsa.com

0034-3617/<https://doi.org/10.1016/j.repl.2018.08.031>

Eastman extends distribution

Eastman Automated Cutting Machines has appointed iSpecc as distributor.

Eastman produce a variety of cutting machines which perform automated cutting of materials. Standard and bespoke cutting equipment is available with a multitude of cutting heads and material handling options.

Eastman's suite of intelligent controls and software solutions include Eastman cutPRO, an operating system, patternPRO for design and nesting of patterns to minimize waste, EasiSelect for selection processing and Digitiser to trace and record all parts.

Eastman are members of the Advanced Manufacturing Research Centre in Sheffield where an Eastman S125 cutting system is in place.

iSpecc Limited; www.ispecc.com

0034-3617/<https://doi.org/10.1016/j.repl.2018.08.030>

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Price adjustment for Lanxess compounds



Durethan engineering plastics (PA 6 and PA 6.6 compounds) are used in numerous applications. (Photo courtesy Lanxess AG.)

Lanxess says that it is raising its prices for Durethan A (polyamide 6.6) compounds in Europe, Middle East and Africa by EUR 0.60/kg with immediate effect.

'The overall tight market situation with extremely limited availability of raw materials in the PA 6.6 value chain has led to further severe price increases for PA 6.6 base resin,' the company said in a press release. 'As there are no signs of a relief, a price adjustment is unavoidable.'

Lanxess added that its materials business unit will offer support in exploring opportunities to replace PA 6.6 applications by PA 6 or PBT grades.

Lanxess;
www.lanxess.com

0034-3617/<https://doi.org/10.1016/j.repl.2018.08.033>

Kordsa among best employers in Brazil for third consecutive year

Turkish composites company Kordsa's facility in Brazil has been listed among the best employers in Brazil for the third time, by the Great Place to Work Institute (GPTW). Kordsa was ranked in fourth place and was the only industrial company to be included in the list.

'This recognition is an output of the steps we take towards becoming a global employer brand,' said Kordsa CEO, Ali Çal şkan. 'We see our human resources as our greatest asset. [...] With this understanding, we encourage our employees to be inspired from each other and inspire each other, care about their

own development, and live a balanced, happy life.'

Great Place to Work focuses on improving workplace culture and strategic organizational culture, focusing on employees.

Kordsa; www.kordsa.com

0034-3617/<https://doi.org/10.1016/j.repl.2018.08.032>

Composite facility certified for aerospace and defense

Reinforcement specialist Kordsa says that its composite manufacturing facility has received BS EN ISO 9001:2015 and EN 9100:2016 (AS9100D) international certification for quality and risk management in aerospace and defense industry.

The facility is located at the Composite Technologies Center of Excellence, at Sabanc University, Istanbul, Turkey and carries out research, technology and product development, entrepreneurship and production processes in composites

technologies. It is now compliant with Aerospace and Defense Industry Quality and Risk Management Standards.

Kordsa; www.kordsa.com

0034-3617/<https://doi.org/10.1016/j.repl.2018.08.031>

Eastman extends distribution

Eastman Automated Cutting Machines has appointed iSpecc as distributor.

Eastman produce a variety of cutting machines which perform automated cutting of materials. Standard and bespoke cutting equipment is available with a multitude of cutting heads and material handling options.

Eastman's suite of intelligent controls and software solutions include Eastman cutPRO, an operating system, patternPRO for design and nesting of patterns to minimize waste, EasiSelect for selection processing and Digitiser to trace and record all parts.

Eastman are members of the Advanced Manufacturing Research Centre in Sheffield where an Eastman S125 cutting system is in place.

iSpecc Limited; www.ispecc.com

0034-3617/<https://doi.org/10.1016/j.repl.2018.08.030>

New UK distribution for press manufacturer

Composites equipment specialist iSpecc Limited has signed a contract to become the UK distributor for Pinette PEI, which makes press systems and hot drape formers. The company's QSP quilted stratum process, reportedly allows a one-minute cycle time of net shape composite parts. Pinette also makes metal brake and shear presses under the Jean Perrot brand.



Jerome Hubert, Pinette president and CEO, with Nigel Clifford, iSpecc MD.

'Productivity in lightweight product manufacturing either in small series or large volume is a must for our markets,' said Jerome Hubert, PEI president and CEO. 'Pinette PEI wants to serve the UK market with a partner close to customers.'

iSpecc; www.ispecc.com

0034-3617/<https://doi.org/10.1016/j.repl.2018.08.029>

Composites UK joins EuCIA

The European Composites Industry Association (EuCIA), the European platform for the composites industry, has added Composites UK, the trade association for the UK composites industry, as a member.

Headquartered in Brussels, EuCIA represents European national composites associations, as well as industry-specific sector groups, at EU level.

Composites UK's mission is to encourage growth and development of the UK composites industry, promoting the best practice use of composite materials. Founded in 1989, the association has nearly 350 members.

According to Composites UK's chairman, Chris Taylor, one of the association's



Composites UK aims to support knowledge transfer, skills, apprenticeships and the need for further education. (Image courtesy National Composites Centre.)

primary roles involves representing the industry's interests in complex legislation,

and this is one of key factors in its decision to join EuCIA.

'We need to have a stronger voice in the legislative decisions taken beyond the UK and as Brexit approaches being part of a European organisation is now more relevant than ever,' he said. 'Europe is a substantial market for the UK and to be part of that, and able to influence it, is crucial.'

**Composites UK;
www.compositesuk.co.uk**

0034-3617/<https://doi.org/10.1016/j.repl.2018.08.028>

Diab appoints new CEO

Diab Group, which makes composite core materials, has appointed Tobias Hahn as its new CEO.

Hahn was previously president of Industrial Assembly Solutions and held various positions within ITT Flygt in Sweden and the USA. He has 10 years of operative and international experience from the Atlas Copco Group.

He replaces Lennart Hagelqvist after six years as CEO, and in the interim Mats Persson, current EVP EMEA and India, will take on the role as acting CEO alongside his current role.

'We thank Lennart for his efforts and important contributions,' the company said in a press release.



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'After my few months with Diab I acknowledge how well positioned we

are,' added Mikael Jonson, chairman of the board. 'We are geographically where we need to be, our brand is well respected and we are acting in a growth market.'

'The board of directors together with our owners has come to the conclusion that Diab need a different leadership going forward. And we believe Tobias is the right choice for Diab in the exciting future that is ahead.'

Diab; www.diabgroup.com

0034-3617/<https://doi.org/10.1016/j.repl.2018.08.027>

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Future of bio-based polymers

German-based nova-Institute has published a new market report about trends in the bio-based polymers market.

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According to the researchers, the production capacities of bio-based polymers continue to grow at around 3 to 4% per

annum, at about the same rate as petrochemical polymers. The market share of bio-based polymers in the total polymer market remains constant at around 2%. However, the individual development of different bio-based polymers varies considerably, the Institute says. While some such as bio-PET are virtually collapsing compared to previous forecasts, many, such as PLA, are showing constant or slightly increasing capacities and a few are even showing significant growth. Additionally, for some bio-based polymers such as PHA,

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nova-Institute; www.nova-institut.de

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'Being a partner in the DMRC allows us to connect with a diverse array of companies across sectors, all with a common goal – to optimize manufacturing for the future,' said Stephan Beyer, CEO of BigRep.

BigRep; www.bigrep.com

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Axon Automotive moves to bigger factory

Axon Automotive Ltd has moved from its start-up location in Wollaston, Northamptonshire, UK to a bigger 4180 m² factory site nearby. This relocation, funded by new parent company Bawtry Investments Ltd, reportedly follows a fourfold increase in business over the last two years.

'The new Brackmills site has provided us with much needed factory space to expand capacity, enabling us to install a completely new in-line production facility, currently being built, which should be commissioned by the middle of this year,' said Chris Taylor, MD of Axon Automotive.

The company supplies carbon fiber-reinforced plastic (CFRP) composite beam making process technology to make lightweight vehicle chassis and structural components. The CFRP based system can be used to produce a vehicle frame which needs rigidity and



Axon's new factory site at Brackmills Industrial Estate. (Photo courtesy Brackmills Industrial Estate.)

high impact crash resistance performance.

Axon Automotive Ltd; www.axonautomotive.com

0034-3617/<https://doi.org/10.1016/j.repl.2018.08.022>

Arburg celebrates ten years in Mexico



From right to left: Gerhard Böhm, managing director sales, Juliane Hehl, managing partner, Guillermo Fasterling, subsidiary manager Arburg Mexiko, and Andreas Carta, director sales overseas.

Injection molding specialist Arburg's subsidiary in Mexico has celebrated its ten-year anniversary.

Arburg's activities in Mexico began with the sale of its first injection molding machines in the 1980s. Due to market potential, the company decided to found its own subsidiary in 2008. 'This was a significant milestone for us and marked an important step towards the successful development of our company in Mexico,' said Gerhard Böhm, sales MD at Arburg. The company next moved to the Queretaro City, central Mexico, in 2013. The Mexican Arburg team now has 25 employees, including experts in application technology, automation and turnkey projects.

www.arburg.com

0034-3617/<https://doi.org/10.1016/j.repl.2018.08.021>

Brazilian composites sector reports growth in 2017

In 2017, sales in the Brazilian composites sector totaled US\$720 million, 1.9% than the previous year, according to a report commissioned by the Latin American Composite Materials Association (ALMACO).

The association says that this is the first positive result since 2014, when the Brazilian economic crisis began. The consumption of raw materials increased 23.2%, amounting to 196,000 tons, while the number of jobs fell 0.9%, totaling 59,000 jobs.

'The transportation market was crucial for us to achieve this performance, especially due to the high demand for agricultural vehicles, such as tractors and harvesters,' said Gilmar Lima, president of ALMACO. 'It is worth noting that poles

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The company supplies carbon fiber-reinforced plastic (CFRP) composite beam making process technology to make lightweight vehicle chassis and structural components. The CFRP based system can be used to produce a vehicle frame which needs rigidity and



Axon's new factory site at Brackmills Industrial Estate. (Photo courtesy Brackmills Industrial Estate.)

high impact crash resistance performance.

Axon Automotive Ltd; www.axonautomotive.com

0034-3617/<https://doi.org/10.1016/j.repl.2018.08.022>

Arburg celebrates ten years in Mexico



From right to left: Gerhard Böhm, managing director sales, Juliane Hehl, managing partner, Guillermo Fasterling, subsidiary manager Arburg Mexiko, and Andreas Carta, director sales overseas.

Injection molding specialist Arburg's subsidiary in Mexico has celebrated its ten-year anniversary.

Arburg's activities in Mexico began with the sale of its first injection molding machines in the 1980s. Due to market potential, the company decided to found its own subsidiary in 2008. 'This was a significant milestone for us and marked an important step towards the successful development of our company in Mexico,' said Gerhard Böhm, sales MD at Arburg. The company next moved to the Queretaro City, central Mexico, in 2013. The Mexican Arburg team now has 25 employees, including experts in application technology, automation and turnkey projects.

www.arburg.com

0034-3617/<https://doi.org/10.1016/j.repl.2018.08.021>

Brazilian composites sector reports growth in 2017

In 2017, sales in the Brazilian composites sector totaled US\$720 million, 1.9% than the previous year, according to a report commissioned by the Latin American Composite Materials Association (ALMACO).

The association says that this is the first positive result since 2014, when the Brazilian economic crisis began. The consumption of raw materials increased 23.2%, amounting to 196,000 tons, while the number of jobs fell 0.9%, totaling 59,000 jobs.

'The transportation market was crucial for us to achieve this performance, especially due to the high demand for agricultural vehicles, such as tractors and harvesters,' said Gilmar Lima, president of ALMACO. 'It is worth noting that poles

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for power grids also contributed, hence considering the infrastructure sector.'

The report says that 2018 sales could reach US\$790 million, 9.4% higher than in 2017, while the consumption of raw materials could grow 4.8%, corresponding to 205,000 tons.

Composite flexibility

'Transportation, agribusiness and infrastructure will continue to grow,' it said. 'In

parallel, segments that faced many difficulties over the past two years, such as the construction, wind and gas, should report a recovery. And new niches will continue to emerge, albeit slowly, supported by the flexibility and lightness typical of composites.'

Despite these results, Lima said that he did not consider the negative phase faced by the composites sector since 2014 fully ended. 'We have lost a lot in the past

three years,' he explained. 'In terms of volume, in 2016 we repeated the results of 2006. [...] Now we need to stay alert, rethink our organizations and seek financial and strategic alliances to help us invest in education, innovation and communication.

ALMACO; www.almaco.org.br

0034-3617/<https://doi.org/10.1016/j.repl.2018.08.020>

Nanomaterials project to reduce greenhouse gases

Plastics technology center AIMPLAS, based in Spain, has launched a new project focusing on greenhouse gas emissions into the atmosphere.

The project, entitled CARMOF, involves building a complete demonstrator of a new process to capture and separate CO₂ based on the use of nanomaterials (graphene, carbon nanotubes and metal-organic frameworks) combined with membranes, made using 3D printing. This could lead to an increase of an adsorption



The project focuses on greenhouse gas emissions into the atmosphere.

area, while CO₂ recovery will be carried out by means of more efficient heating technologies due to the application of the Joule effect. The structures will be installed at the emission points of ceramic, petrochemical and steel industries.

The project has a duration of 48 months and has received funding from a research and innovation European Union program.

AIMPLAS; www.aimplas.net

0034-3617/<https://doi.org/10.1016/j.repl.2018.08.019>

Safety award for FRP company

Composites One says that it has been presented the Platinum Award by insurance firm Great West Casualty Company as part of its 2017 National Safety Awards Program. This is reportedly the 16th consecutive year that Composites One LLC has been named an award recipient and the 15th Platinum Award in as many years.

The National Safety Awards Program recognizes carriers in similar operations (truckload and less than truckload) with awards based on their year-end preventable accident results. Carriers are eligible to receive a Platinum, Gold, Silver or Participatory Award.

'Safety is a core value at Composites One and a constant focus at all our locations,' said Leon Garoufalis, president.

**Composites One;
www.compositesone.com**

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Technology

Solvay supplies materials for AM

Delta Equipement, a French supplier of automation, robotics and additive manufacturing (AM) technology and Solvay, have partnered to make AM parts.

Solvay will supply its Radel polyphenyl sulfone (PPSU) and KetaSpire polyetherether ketone (PEEK) filaments, including carbon fiber filled PEEK grades, for use on Delta's fused filament fabrication (FFF) systems.

'Partnerships such as the one with Delta Equipement are part of our strategy to develop and become a world-wide leading supplier of advanced AM-ready polymer solutions for 3D printing technologies,' said Christophe Schramm, business manager at Solvay.

According to the company, a new generation of polymer filaments could open new opportunities for applications with demanding mechanical and thermal requirements.



Delta Equipement offers filaments for fused filament fabrication (FFF), including KetaSpire PEEK, carbon fiber filled PEEK and Radel PPSU filaments from Solvay.

'3D printing is a disruptive technology that requires new system solutions to exploit its full innovation potential,' said Yves Daunas, Delta president.

Solvay; www.solvay.com

0034-3617/<https://doi.org/10.1016/j.repl.2018.08.059>

Upcycling PET for reinforced parts

A German project team has developed a process to recycle polyethylene terephthalate (PET) to make glass fiber reinforced PET.

The new research project, UpcyclePET recovers PET waste from plastic bottles in industrial applications, reducing the use of new polyamide-based parts.

The project team consists of the company Easicomp GmbH, the Fraunhofer Institute for Structural Durability and System Reliability LBF, and the Institute for Applied Ecology (Öko-Institut eV).

'We would not like to use recycled PET just for plastic bottles, but would also like to use it in the production of durable and

long lasting products,' said Dr. Ing Tapio Harmia, CEO of Easicomp.

'With this upcycling we are creating lightweight components out of fiber-reinforced recycled PET, and are thus reducing the use of glass fiber reinforced polyamides typically applied in the production of automotive parts, e.g. engine mounts or cross members,' added Dr. Volker Strubel, project coordinator.

The process uses pultrusion to reinforce the PET with long glass fibers. According to the project members, this can make use of the mechanical advantages of the very strong long glass fibers with the special properties of PET. There is also reportedly

less swelling capacity and improved dimensional stability. All necessary processing steps can be completed in one manufacturing plant.

Environmentally friendly

'This approach combines two processing steps that are separated in modern practice and customizes the properties of the recycling PET by chemical modifications and suitable addition of additives,' said Dr. Frank Schönberger, department head at Fraunhofer LBF.

'We are expecting an innovation boost for high quality plastics recycling in Germany from the UpcyclePET project,'



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said Dr. Andreas Köhler, a researcher at Öko-Institut. 'Upcycling of PET waste has significant potential as an environmentally friendly solution, since it facilitates

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Fraunhofer LBF;
www.lbf.fraunhofer.de

0034-3617/<https://doi.org/10.1016/j.repl.2018.08.058>

NSF award to develop tension control for composites

Montalvo, which specializes in web tension control products, has been awarded a National Science Foundation (NSF) small business innovation research (SBIR) grant for US\$750,000 to develop a new way to control individual tow tension in composites manufacturing.

After successfully completing a phase one grant for feasibility studies and commercial review, Montalvo will utilize the second phase of funds to commercialize the product.

'Our expertise in tension control technology gives a unique insight into

the composites manufacturing processes and the problems that a lack of consistent, uniform, and regulated individual tow tension control created,' said Montalvo's director of engineering, Chris Osgood.

Montalvo; www.montalvo.com

0034-3617/<https://doi.org/10.1016/j.repl.2018.08.057>

Mill can process recycled glass fiber

Union Process, which makes particle size reduction and dispersing equipment, has developed a dry grinding SDL250 machine (Attritor) that can be used for recycling fiber material.

'This is a fairly new application for our Attritors,' said sales manager Chuck Major. 'The customer needed a specially designed heavy-duty mill for continuous dry milling of fiberglass and our SDL250 met their requirements. We included a specially designed material deflector to aid in material feeding.'

'Our customer is thrilled to be able to recycle material that they had previously been discarding as scrap,' he added.



The dry grinding SDL250 machine can be used for recycling fiber material.

The stainless-steel mill features an elongated design and a flanged inlet for screwfeeding the material. It has a 250 HP TEFC motor suitable for a variable frequency drive (VFD). The mill includes a G-series reducer comprised of a heavy-duty right-angle gear box with cooling fan and hardened tool steel agitator arms. Product discharge is achieved via two metering valves for material discharge flow control

Union Process;
www.unionprocess.com

0034-3617/<https://doi.org/10.1016/j.repl.2018.08.056>

Kordsa commissions new production line

Kordsa says that a new production line of polypropylene monofilament fiber reinforcement, based in the company's İzmit, Turkey, plant, is now operational.

With this new investment, Kordsa has also expanded its product range with the production of polypropylene monofilament fiber concrete reinforcement for the construction industry.



A new production line of polypropylene monofilament fiber reinforcement, based in Kordsa's İzmit, Turkey, plant, is now operational.

'With this new polypropylene monofilament fiber reinforcement line, we aim to grow by differentiating from our competitors in the market,' said Kordsa CEO Ali Çal şkan. 'We aim to offer this new synthetic fiber, a new version of KraTos, both in Turkey and in the European market.'

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Tests show off hybrid composites

Tri-Mack Plastics Manufacturing Corporation says that a recently completed test demonstrates the bond strength of Tri-Mack's overmolded thermoplastic composite hybrid parts. The comparative test, similar to the ASTM 4501 block shear test, was conducted by the company with test coupons manufactured in-house and reportedly helps validate the performance of hybrid composites. They could be suitable for aerospace and other industries where a lighter weight and lower cost are important.

Tri-Mack's hybrid panel is made in a robotic injection-molding cell that forms

the composite geometry and produces a multi-piece assembly (including hardware) from the mold. Tri-Mack tested the strength of hybrid overmolded coupons, all-laminate coupons (to establish a baseline), and laminate coupons bonded together with industry-standard thermoset film adhesive.

Results revealed that the bond between the unidirectional thermoplastic composite and the injection-molded thermoplastic was 85% the strength of the base laminate and twice as strong as the industry standard adhesive.

'Aircraft manufacturers face huge backlogs and some of this is attributed to supply chain capacity and coordination,' said Tom Kneath, director of sales and marketing at Tri-Mack. 'But innovation in part design and commitment to technology can help to solve these problems. Our hybrid parts are an example of meeting expanded functionality requirements and customer business goals in one stroke.'

Tri-Mack;
www.trimack.com

0034-3617/<https://doi.org/10.1016/j.repl.2018.08.054>

Degradable glass fiber polymer wins innovation award

Finland-based Arctic Biomaterials has won a bio-based material of the year innovation award for its degradable glass fiber reinforced polylactic acid (PLA).

Belgian company Cardolite Corporation also won an award for its cashew nut-shell residual-based blocking agent, while

Spain-based AIMPLAS (Spain) was awarded a prize for its biodegradable nets for green beans. The special award of the jury was given to Warka Water (US) for a water collecting bio-based tower in dry areas.

The 'Bio-based Material of the Year 2018' focused on new developments in

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nova-Institute;
www.nova-institut.de

0034-3617/<https://doi.org/10.1016/j.repl.2018.08.053>

EOS launches new plastic 3D printer

Additive manufacturing (AM) specialist EOS has launched a new 3D printer specifically designed to process its new carbon-fiber reinforced material, HT-23.

EOS P 810 has been developed with Boeing for the aerospace industry but can also be applied for other industries. It is based on the EOS P 800 and has a build volume of 700 × 380 × 380 mm and two 70 Watt lasers. It is particularly suited for industrial applications, EOS says.

'The aerospace industry has to meet challenging requirements when it comes to UV resistance, flame retardancy and meeting Federal Aviation Regulations (FAR),' said Scott Killian, aerospace business development manager at EOS. 'Additive manufacturing enables the design and manufacturing of complex geometries without expensive tooling. This allows aerospace OEM's to replace composite parts which to date are being produced manually via carbon fiber laminating. They can also replace aluminum parts with HT-23 while still meeting the material strength properties required for the application.'

HT-23 is reportedly the first carbon fiber-reinforced PEKK material that can be processed on EOS systems. Parts additively manufactured with this material offer high strength, low weight and are capable of withstanding high temperatures. It is



EOS P 810 has been developed with Boeing for the aerospace industry.

reportedly the first material with a low refresh rate of 40%.

Weight reduction

'Our EOS P 810 polymer 3D printing platform and the ALM HT-23 material enabled us to help Boeing reach high demands for weight reduction, cost efficiency and reduced assembly time for components,' said Killian. 'The technology platform addresses Boeing's needs and allows them to achieve homogenous part properties

within the overall building volume, a key factor for cost efficient manufacturing of air ducts, small turbines and holders.'

The material is also suitable for applications such as plugs or housings, serial parts and spare parts for the interior and exterior (exterior facing) of busses and trains. Parts made of HT-23 fulfil the regulation EN 45545.

EOS; www.eos.info

0034-3617/<https://doi.org/10.1016/j.repl.2018.08.052>

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Boost for thermoplastic honeycomb production

EconCore, which makes cores and sandwich material, says that it is making strong progress in development of new all-thermoplastics continuous honeycomb cores. This follows the installation of a laboratory-scale extrusion and forming line at the company's R&D facilities in Leuven, Belgium.

The line includes a 50 mm extruder, built by machine specialist MEAF from Yerseke, the Netherlands, and equipped with a 500 mm sheet die built by flat-die specialist EMO Extrusion Molding from Micheldorf, Austria.

EconCore honeycomb structures are produced from a single continuous thermoplastic sheet using the company's ThermHex technology. This involves a sequence of thermoforming, folding and bonding operations. Cell size, density and thickness of the honeycombs can be altered with hardware and/or process parameter adjustments. The process allows for inline bonding of solid skins to one or both sides of the honeycomb, to create a finished composite panel.

Before installing the new extruder, EconCore was carrying out its honeycomb developments using sheet unwound from a roll. 'Now that we can produce our own sheet in-line, we have more flexibility in our operations and it is obviously much easier to make changes to the material formulations,' said Wouter Winant, the company's technical manager.



EconCore partnered with MEAF to develop lab extruder for continuous thermoplastic honeycomb production.

Process technology

The extruder can process polyolefins, bioplastics and thermoplastics such as polycarbonates, polyamides, and polyphenylene sulphide. 'This is a non-typical setup, but it is very important for our development work,' added Winant. 'EconCore already has licensees around the world producing continuous honeycombs and honeycomb-cored laminates in polyolefins – predominantly polypropylene – and we

intend to continue refining the process technology for these materials. The new line is partly intended for this purpose.

'At the same time though, we are extending the potential of ThermHex technology by enabling it to be used with thermoplastics with superior mechanical and thermal performance.'

EconCore; www.econcore.com

0034-3617/<https://doi.org/10.1016/j.repl.2018.08.051>

Software helps spacecraft development

Collier Research Corporation says that its HyperSizer software is being used by the Sierra Nevada Corporation (SNC) in the development of its Dream Chaser spacecraft.

The team is currently now reviewing flight performance data and refining the vehicle's design adaptations to meet mission requirements and changing payloads, using the Corporation software.

The HyperSizer tool provides insights into the strength, weight, and manufacturability of designs for composite and metal structures and could reduce the weight of existing designs by 20–40%. According to Collier, the software plays an important role in margin-of-safety certi-



The Dream Chaser will transport pressurized and unpressurized cargo to and from the International Space Station (ISS). (Photo courtesy SNC.)

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The current model of the autonomous, reusable Dream Chaser, named Commercial Resupply Service 2 (CRS-2), will transport pressurized and unpressurized cargo to and from the International Space Station (ISS) and is planned to launch in late 2020. The vehicle also could be used for satellite servicing, orbital-debris removal and exploration technology testing.

Composite forming facility opened

Rhodes Interform, a specialist in bespoke hot and cold composite and metal forming machinery, has installed a composite forming facility at the University of Sheffield's Advanced Manufacturing Research Centre (AMRC).

The aim was to design, develop and manufacture a composite press to assist a wide range of UK companies in composite development.

Rapid analysis

'HyperSizer's suite of industry-standard failure criteria was extremely valuable for our team, enabling us to quickly size the Dream Chaser structure and perform architectural trade studies,' said Andy Kim, senior structural engineer for SNC. 'The software's rapid analysis capability gave us more time to interrogate our results and gain insights into the sensitivity of the structural weight to various design features and stiffener cross sections.'

'HyperSizer helped us improve and automate the design-analysis process for the CRS-2,' added Eric Schleicher, principal structural engineer. 'We found some of the most useful aspects of the software to be load processing, sizing, margin reporting and the finite-element model [FEM] update feature.'

**Collier Research;
HyperSizer.com**

0034-3617/<https://doi.org/10.1016/j.repl.2018.08.047>

The facility comprises a 10,000 kN hydraulic press with six axis loading, high pressure resin transfer molding (RTM), twin die transfer tables, thermal fluid heating system and die splitter. It covers a range of composite forming including open and closed moulding, RTM, prepreg, compression molding and thermoplastics. The project attracted funding from the

Government's Advanced Manufacturing Supply Chain Initiative (AMSCI).

**Rhodes Interform;
www.grouprhodes.co.uk**

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Conference Showcase

Conference showcase introduction

Composites Europe exhibition takes place in Messe Stuttgart, Germany from 6-8 November 2018.

We look at some of the products, technologies exhibitors will be showcasing.

0034-3617/<https://doi.org/10.1016/j.repl.2018.09.002>

Oxford Advanced Surfaces

Oxford Advanced Surfaces are introducing a new addition to its range of Onto™ adhesion promoters for composites and engineering plastics.

Onto™ adhesion promoter replaces other surface preparations methods for adhesive bonding, painting and coating, removing the need for sanding, vapor blasting, or plasma. Simply degrease and apply Onto™.

Onto™ makes surface preparation quick and easy, helping reduce costs, improve productivity, remove risk of damage, and improve adhesion. It is particularly suitable for volume manufacturing and is easy to integrate into existing processes both manual and fully automated without the need for specialist equipment.



Onto™ products have been developed to work with most composite and

reinforced plastics, as well as a wide range of engineering plastics. It is equally effective on materials that are difficult to bond, paint or coat, such as nylons (PA).

Within reason, there are no time limits of the surface activity when using Onto™, allowing materials to also be treated efficiently in batches and used either immediately or over a period of weeks or months.

New Onto™ SB2050 has been introduced for use with MMA adhesives, while the existing product range is suitable for both epoxy and polyurethane adhesives and coating.

<https://www.oxfordsurfaces.com>

Stand No. 9/C781

0034-3617/<https://doi.org/10.1016/j.repl.2018.08.008>

Arctic Biomaterials Oy

Arctic Biomaterials Oy (ABM) is a company based in Finland producing bio-based and biodegradable plastics. ABM speciality is using a degradable glass fiber as reinforcement for bio-based and/or biodegradable plastics. An example of a material we will be highlighting at the expo is ArcBiox BGF30-B1 (winner of the 2018 bio-based material of the year award by Nova Institute).

ArcBiox™ BGF30-B1 is a Polylactic Acid (PLA) that is reinforced using LFT (long fibre) technology with a special degradable glass fibres. This innovation makes it possible that bio-based plastics can be used in technically demanding dur-



able applications and still have the option of biodegradation at the end of life. The reinforcement is a glass fibre developed by Arctic Biomaterials Oy and can also be used for several other bio-based polymers.

This composite material reduces the carbon footprint and use of non-renewable energy of a composite product drastically compared to fossil-based reinforced plastics. This reinforced PLA is compostable and certified by the seedling mark from DIN CERTCO.

Using degradable glass fiber as reinforcement makes it possible to use the materials in demanding technical applications while still keeping the sustainable end of life options.

www.abmcomposite.com

Stand No. H7/A45_P.

0034-3617/<https://doi.org/10.1016/j.repl.2018.08.007>



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0034-3617/<https://doi.org/10.1016/j.repl.2018.08.007>

ThermHex Waben GmbH

ThermHex Waben GmbH offers the new standard of polypropylene (PP) honeycomb cores, which has proven to be an excellent choice for producers of sandwich composite panels. The international patented, continuous ThermHex production process enables a cost efficient and highly automated inline production of honeycomb cores. ThermHex honeycomb cores are particularly in demand for ship interiors, rigid truck boxes, swimming

pools and more and more in the automotive industry. Established in 2009, ThermHex Waben GmbH is a licensee of EconCore NV, the technology leader in economic sandwich material production technologies.

Conference highlights

- Polypropylene honey comb cores with different core thickness, cell size, density and surface finish.

- Newest product: polypropylene honeycomb core, thickness: 15 mm, cell size: 5 mm, better surface finish
- New vacuum forming roll.
- Also new: Depending on a customer's purchase quantity, the polypropylene honeycomb cores can be produced with individual properties.

www.ThermHex.com

Stand No. 7/A03

0034-3617/<https://doi.org/10.1016/j.repl.2018.08.006>

OCSiAl

OCSiAl, a hi-tech company, produces industrial-scale TUBALL graphene nanotubes – an advanced additive that improves the properties of base materials, including composites.

TUBALL nanotubes offer a great leap forward for materials technologies, with exceptional physical properties, nanometric dimensions, and chemical universality. When TUBALL nanotubes are added to composite materials, their properties, such as mechanical strength and electrical conductivity, improve dramatically. TUBALL nanotubes provide significant improvements with the addition of just 0.01%–0.1% by weight, a much smaller amount than is needed with conventional additives.

To facilitate the effective incorporation of TUBALL into materials, OCSiAl provides

TUBALL MATRIX, a line of easy-to-use pre-dispersed concentrates of graphene nanotubes, that can be applied as reinforcing and conductive additives. These enable manufacturers to develop high-performance, conductive, strong, and lightweight composites.

OCSiAl's graphene nanotube concentrates make for standard, clean manufacturing processes without the powder or dust usually associated with conventional additives. The extraordinary properties of graphene nanotubes are opening the door for composite manufacturers to be more competitive by producing next-generation materials with superior electrical conductivity and improved mechanical properties, while reducing costs by decreasing overall

additive loading, material amount, and processing time.

OCSiAl has so far developed TUBALL MATRIX concentrates for epoxy, polyurethane, phenolic, polyester, vinylester, and acrylic-based formulations, as well as many more industrial composite applications.

On 6–8 November at Composite Europe in Stuttgart, stop by OCSiAl booth (#9/C41) to discover how you can design lightweight, strong, conductive and colored composite materials with TUBALL graphene nanotubes.

<http://ocsial.com/>

Stand No. 9/C41

0034-3617/<https://doi.org/10.1016/j.repl.2018.08.005>

KRELUS IR-heaters for composites – and many more products

For more than 40 years, KRELUS have been specialists for Infrared-heaters.

With the emphasis on the special high performance IR-heaters based on an innovative technology, KRELUS customers have a competent partner for both standard and custom made heating solutions. Alongside many more applications some of the interesting areas are:

- Heating of composite materials from carbon-/glass-/natural-fibres containing a matrix of PP/PA/PEEK/etc.
- Embossing of PVC/PA/etc.
- Thermoforming
- Coating of paper, foils, metals, films and textiles
- Lamination of a wide variety of materials etc.

The superior, innovative KRELUS technology applies direct radiation heat from



its resistance source to the product (without any glass quartz or ceramics). High thermal insulation materials prevent heat loss from the reverse side of the heaters.

The very rapid response time of the KRELUS medium-wave IR-heaters allows operations with precise temperature control on the product surface and they can be switched instantly ON and OFF even for short production breaks.

Most products (thermoplastics/paper/textiles) absorb heat energy in the medium wave range

($\pm 3,0 \mu\text{m}$) extremely well.

The emission range of the KRELUS-IR is perfectly matched to these absorption ranges. This fact leads to a higher efficiency and consequently to cost savings in comparison to traditional standard heaters.

KRELUS IR-heaters are available in standard modules in a variety of sizes and capacities. Custom made solutions are available up to approximately 8,000 mm in a single piece. The modular size faci-

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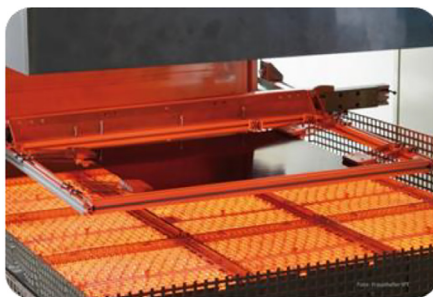
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tates individual control zones of various dimensions or to manage uniform temperature profiles in continuous processes.

Composites Europe in Stuttgart/Hall 7 booth C63m/from 06.–08.11.2018

We shall be pleased to welcome you at our booth in Stuttgart, come and visit us!

KRELUS AG|Ausserfeldstrasse 14|CH-5036 Oberentfelden.

Tel.: +41 (0) 62 739 30 70|Fax: +41 (0) 62 739 30 89.

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|<http://www.krelus.ch>

0034-3617/<https://doi.org/10.1016/j.repl.2018.08.004>

Composites Europe 2018

Company Name: Grasse Zur Composite Testing

Stand No: 7/C14a

Website: www.grassezur.com

About the company

Grasse Composite Testing specializes in the **testing** of fiber-reinforced plastics. The company operates an **accredited material testing laboratory in Germany according to ISO 17025** and has been testing materials for the automotive, aerospace, wind energy and chemical industries for many years. i.a. for BMW, Daimler, Grob Aircraft, Dornier Seawings, Sinoi, Nordex, Hexion, Saertex and Toray. The testing spectrum includes **quasi-static and cyclic tests (fatigue strength) as well as thermoanalytical investigations**.

In addition to material testing as a service for QA and R&D, Grasse Zur Composite Testing develops **composite testing equipment** for material testing. Besides all common devices for mechanical material testing (e.g. Celanese compression fixture, Iosipescu shear fixture, etc.), the portfolio includes the **picture frame as a reference method for shear testing** (DIN SPEC 4885/DIN EN ISO 20337). In addition, a **release agent testing** device has been developed in cooperation with BMW, which enjoys great demand and can characterize both internal and external release agents.

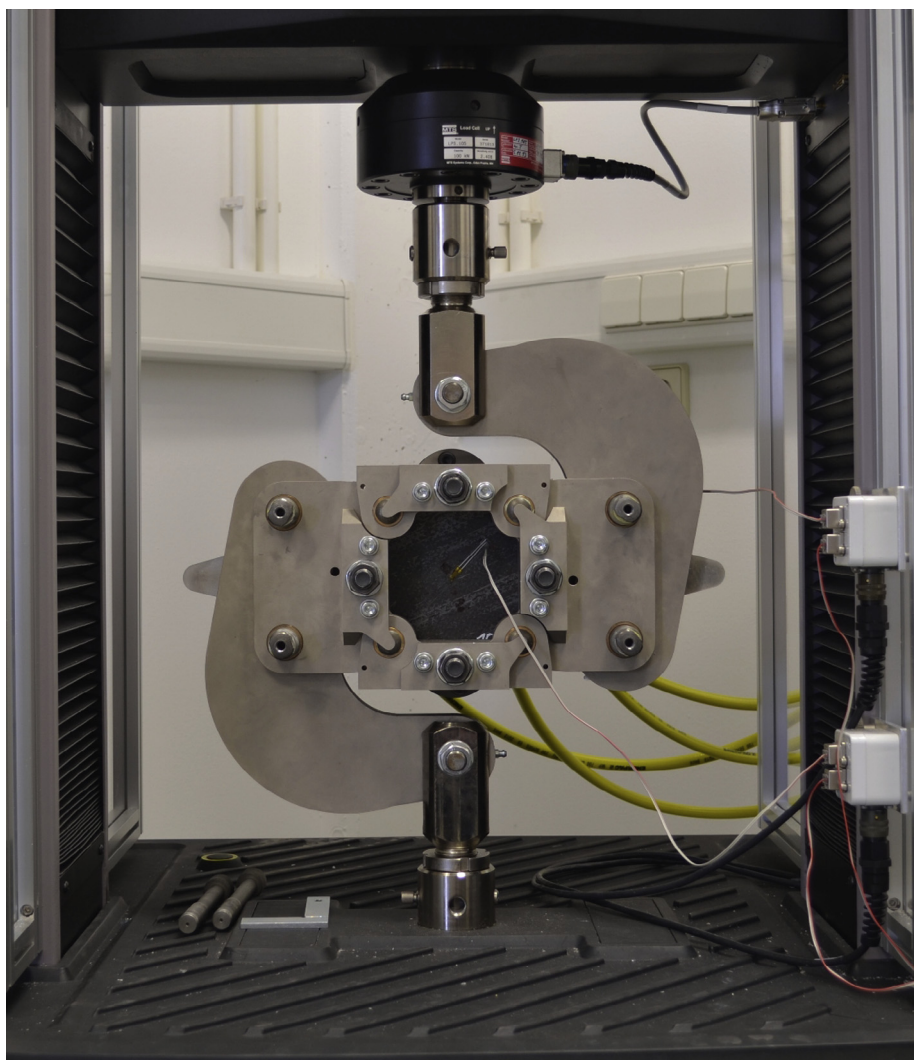
In addition to different seminars around the subject of material testing, Grasse Zur Composite Testing has another highlight in its portfolio for composite testing: the **reference method for online control of curing during production US-Plus®**. The US Plus® technology is **the only curing control on the market that can**

follow the curing process without contact in the mold. The process has been scientifically validated and has been on the market for over twenty years. Users include Daimler, Audi, DLR and many others.

At the Composites Europe 2018, the team at Grasse Zur Composite Testing

will be demonstrating all testing equipment and advising visitors on efficient and optimized testing of composites. In addition, there is again a **special discount** for the trade show with a time limited validity.

0034-3617/<https://doi.org/10.1016/j.repl.2018.08.003>



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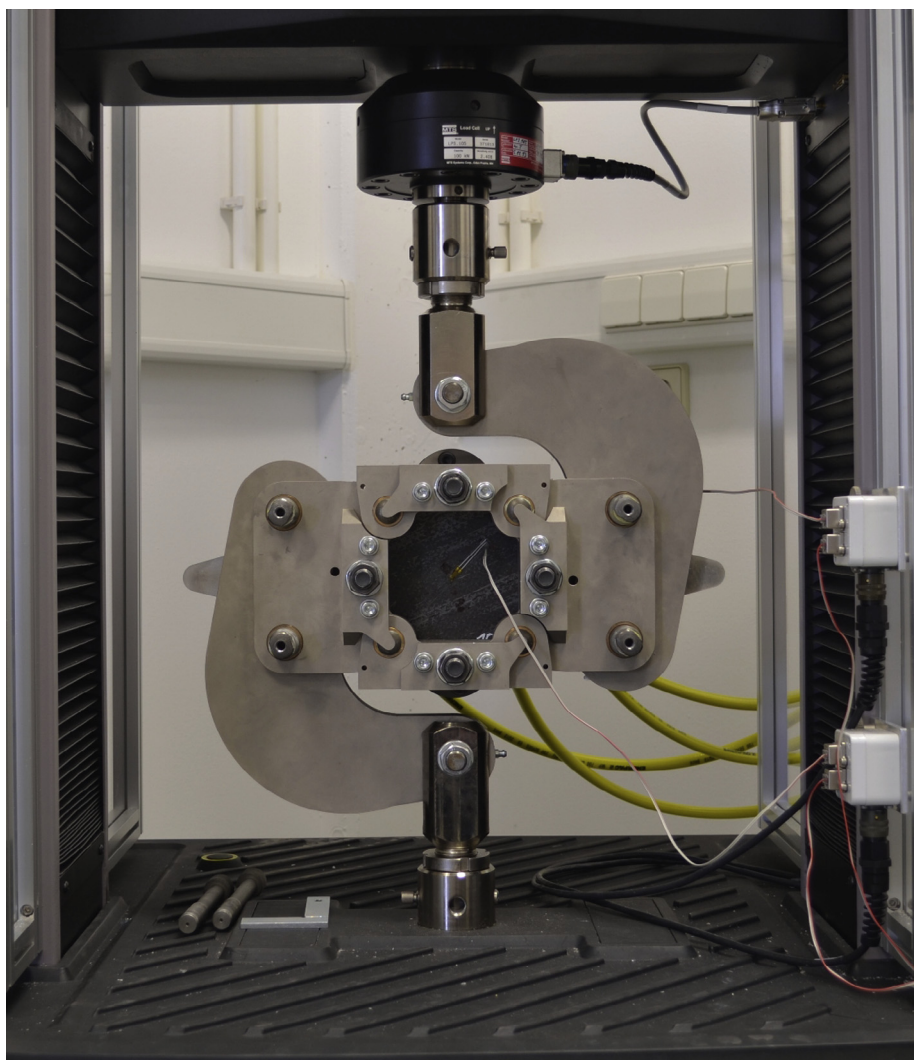
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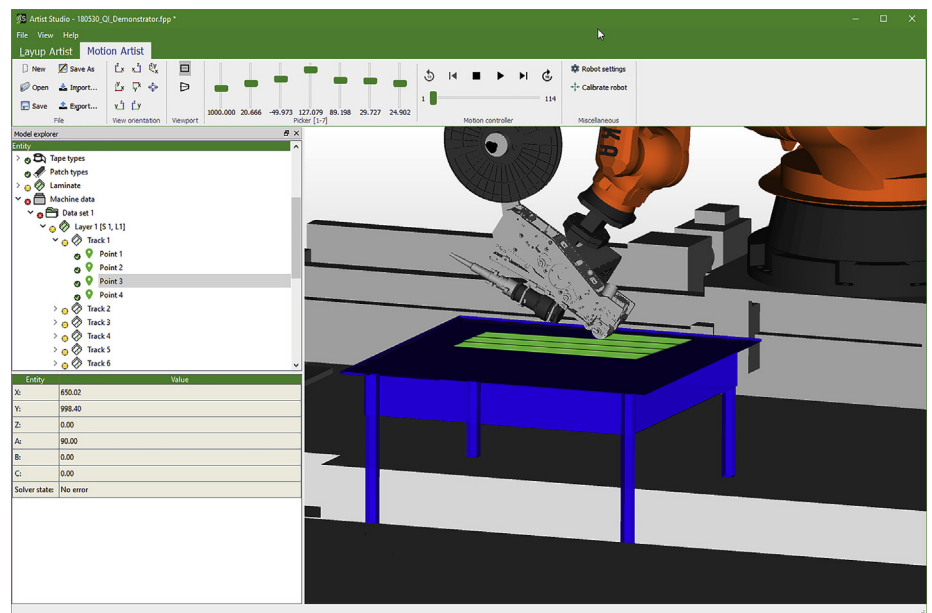


Automated multi-material layup for aerospace

After the release of SAMBA *Prepreg* beginning of the year, the Fiber Patch Placement (FPP) specialists at Cevotec continue to develop their SAMBA *Series*. Currently in focus: automated multi-material layup for complex sandwich parts in aerospace.

“As a result of our work with leading aerospace component manufacturers, we have developed system concepts that focus on aerospace requirements”, comments Cevotec’s CTO Felix Michl. “In particular, we concentrated on the various sandwich components with their challenging material mixes, like adhesive films, glass fiber and carbon fiber, of course.” These different materials are implemented to improve the adhesion and compatibility of carbon fiber material and the often used aluminum honeycomb sandwich core. Cevotec conceptualized a new production cell for the automated lay-up of this special multi-material mix. SAMBA *Multi* features a parallel feeding of the different materials for processing in one SAMBA system. With the option of mounting the Fiber Patch Placement unit on a linear axis, the concept also allows for producing long or broad aerospace components. The patch grippers are scaled to DIN-A5 and DIN-A4 sizes to match common aircraft component sizes. In addition, the patch robot can exchange different gripper sizes easily during the production process with an integrated gripper station. “We are looking forward to present this brand-new concept at Composite Europe Stuttgart”, says Michl.

Cevotec’s software suite ARTIST STUDIO also yields new developments. “During a close cooperation with customers using both FPP and AFP processes, the question arose if laminate planning for FPP and AFP processes can be combined in one ARTIST STUDIO module,” explains Dr. Neven Majic, EVP at Cevotec. “We accepted the challenge and are



currently extending ARTIST STUDIO by the relevant features for laminate design with endless fiber tapes as found in AFP processes.” Seamlessly integrated into ARTIST STUDIO, the new module TAPE ARTIST will also use MOTION ARTIST for machine data generation and process simulation. TAPE ARTIST can also be combined with PATCH ARTIST as one module, so that engineers can design laminates using both AFP and FPP technology. The module will be available commercially towards the end of the year. “Composite Europe therefore will be the right place to gain first-hand information”, Dr. Majic concludes.

At Stuttgart, Cevotec will be found in hall 9 on booth E60e, also presentations on the symposium side stages are planned. Right before the start of Composite Europe, Cevotec will give a detailed insight into the technology at the International Composites Congress (ICC), taking place concurrently with the trade show.

About Cevotec

Cevotec enables manufacturers to build complex fiber composites in high volume and quality – by smart process automation based on Fiber Patch Placement technology. With SAMBA *Series*, Cevotec offers tailored, automated fiber layup systems for challenging 3D geometries and laminates with complex fiber orientation. ARTIST STUDIO is the matching CAD-CAM software for generating patch-based fiber laminates and automated robot programming. Along with development services that include FE-based modeling and simulation, Cevotec offers the entire process chain from digital design to final composites product.

Picture

SAMBA *Multi*

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Cevotec GmbH

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www.cevotec.com

0034-3617/<https://doi.org/10.1016/j.repl.2018.08.002>

BIOWERT introduces masterbatch of colored fibers

The BIOWERT Industrie GmbH has developed a new masterbatch of colored cellulose that can be blended with any polyolefin to create a customized composite. As the grass fiber it contains is extremely pure, even very bright colors are possible.

The BIOWERT Industrie GmbH is known for AgriPlast, a composite that is made up of 30–75 percent cellulose. The natural fibers are extracted from locally sourced grass in a worldwide unique process and mixed with recycled plastics. The result is an environmentally friendly

material that is very versatile and has excellent technical characteristics.

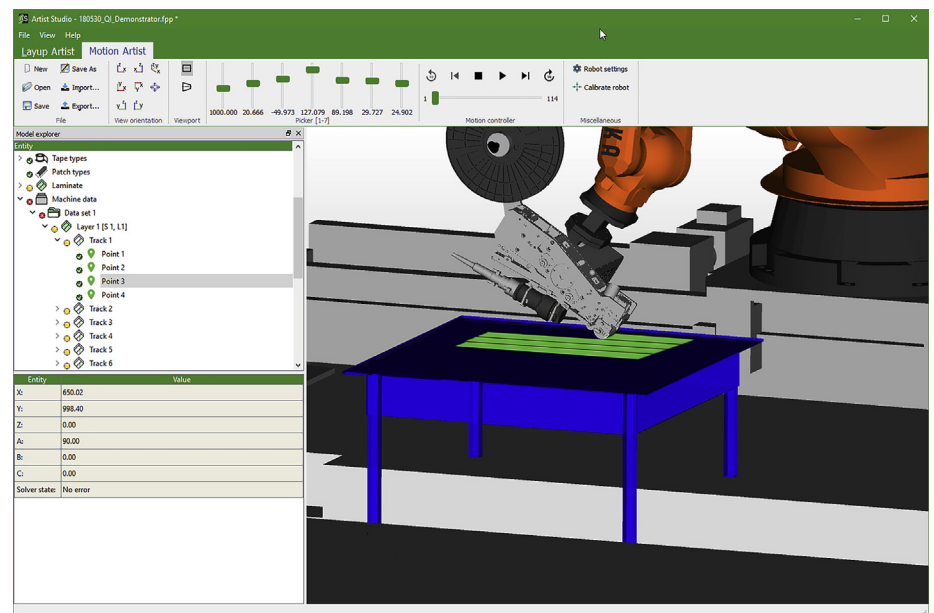
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SAMBA *Multi*

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As the grass fibers are easily purified and can be colored very brightly, BIOWERT has now created a new masterbatch that contains 80 percent cellulose. Manufacturers can blend the colored

fibers with any polyolefin to create a customized composite that meets their individual requirements regarding color and fiber content.

Depending on the thermoplastic matrix used, the resulting material has the same characteristics as AgriPlast, which is easy to handle and suitable for injection mold-

ing and extrusion applications. Due to the cellulose, the material is up to 25 percent lighter than comparable bio composites and at the same time more resistant to abrasion, fire, heat and cold than standard thermoplastics. AgriPlast is 100 percent recyclable but can also be burnt without leaving any residues.

Company name: Biowert Industrie GmbH

Stand No.: 7/A45k

Company website address: www.biowert.com

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Interview with Sebastian Raffauf, Team Sonnenwagen Aachen

INTERVIEW

Sebastian Raffauf

Reinforced Plastics spoke with Sebastian Raffauf from Team Sonnenwagen Aachen about the development of their solar car.

Please can you start by introducing yourself, telling us about your background and that of Team Sonnenwagen Aachen?

My name is Sebastian Raffauf. I am a 26-year-old master's student, majoring in aeronautical engineering. I joined Sonnenwagen Aachen in January 2016 as head of the aerodynamic department. Together with the other five members of the aerodynamic team I am responsible for the aerodynamic design and manufacturing of the carbon fiber reinforced plastics (CFRP) of our solar race car.

The story of Team Sonnenwagen Aachen began in September 2015, more than two years ago, when our founders Hendrik Löbbberdings and Niklas Kaltz watched a solar car race with friends in Aachen and wondered, why there was no German participant in the main challenger class. The race they have been watching happened to be the toughest solar car race in the world – the Bridgestone World Solar Challenge. As part of the World Solar Challenge, more than 50 teams from around the globe race through the Australian outback over 3000 km from Darwin in the north of the continent, to Adelaide in the south. It takes place every two years and attracts attention of both industry and academia.

Interested in competing in the race, a small group started to growing Aachen willing to take on the challenge to develop the first German solar car for the challenger class – the premier discipline of the race. Since Aachen houses the RWTH Aachen university and the FH Aachen, both considered among the best of the German technical schools, Team Sonnenwagen Aachen found many students from different backgrounds willing to contribute to this project (Figures 1 and 2).



FIGURE 1

Sebastian Raffauf.

Could you tell us about your project and its impact?

The obvious reason for engineering students to join Sonnenwagen Aachen, one would say, is to develop a race car. However, the team's goal is of more fundamental nature. We want to change the perception of sustainable mobility and inspire people for this topic.

Here, in Germany, there is a public debate about the future of automobility and the evolution to e-mobility. Although, Germany is known as a great car nation, there seems to be a lack of willingness to strive for this change. Regarding their range and costs, many people nowadays are sceptical toward electric

Corresponding author: s.raffauf@sonnenwagen.rwth-aachen.de



FIGURE 2

Team Sonnenwagen Aachen at the official unveiling in July 2017.

cars. Moreover, people are aware of the fact that e-mobility alone will not solve the energy problem, since conventional power plants still have a big share in power generation in Germany.

We are convinced that Germany presents all important conditions to be a leading nation in the evolution of mobility in the next decades. Therefore, Sonnenwagen Aachen wants to raise awareness for and fight prejudices against e-mobility. With our first solar car we want to demonstrate the possibilities of focused and collaborated research and development (R&D) in the field of solar e-mobility.

In the last two years, we worked on this mission and established a network of sponsors and supporters. In November 2016, we signed Huawei as our main sponsor followed by Covestro and Porsche as sponsors in the spring of 2017. In total we found more than 40 specialized partners from different industry sectors and academic facilities, who strongly supported us and made this whole project possible. Moreover, we even experienced support from politics. Dr. Barbara Hendricks, German minister for environmental affairs, held a speech at the official unveiling and acknowledged the significance of our vision and our team.

What materials do you work with?

Our solar car consists of four different technical sections: the structural frame, the suspension, the aerodynamic shell and the electric system. Whereas the structural frame consists of extra-thin steel tubes and the suspension is designed with

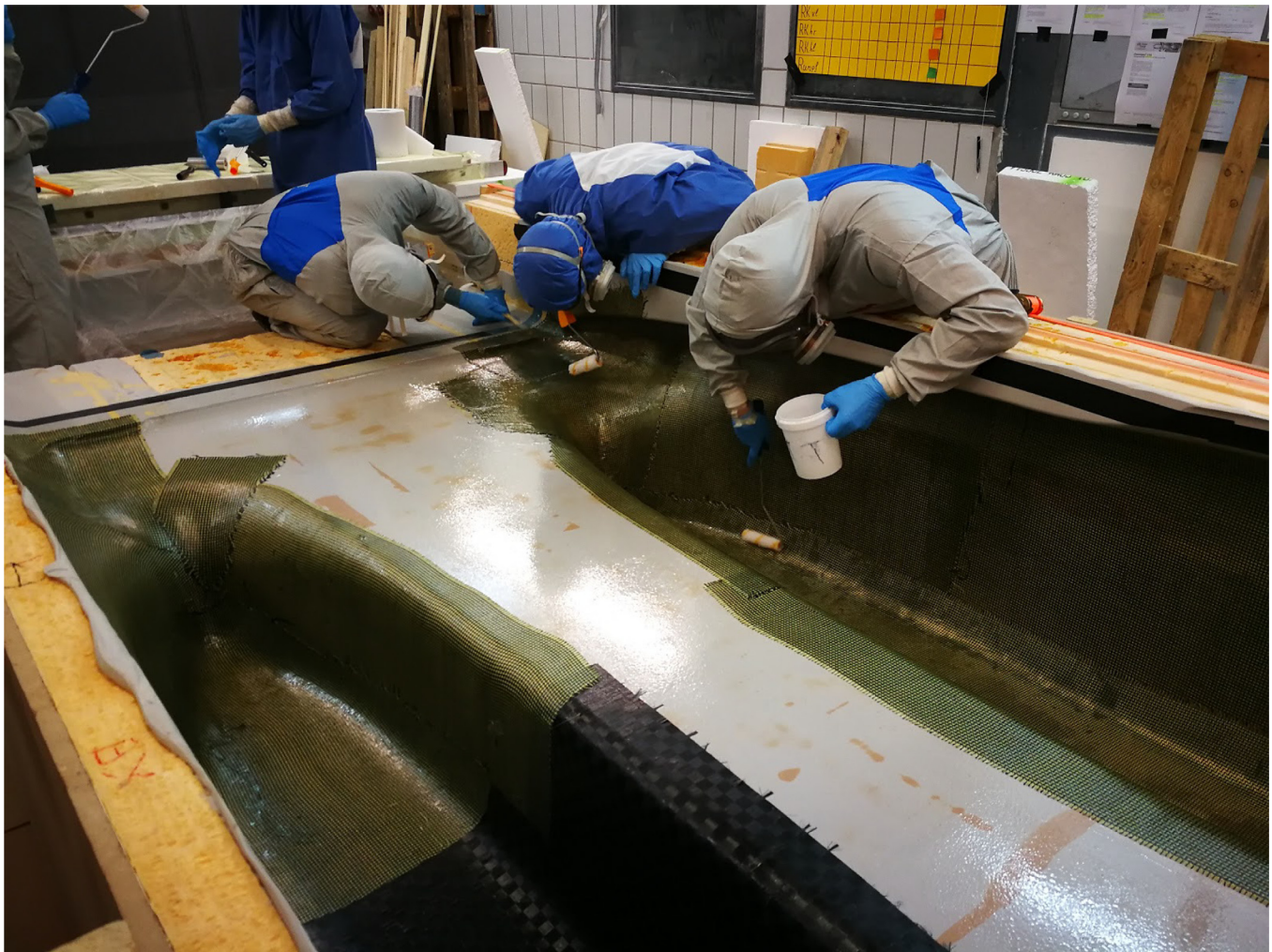
aluminum components, all aerodynamic parts are made out of fiber reinforced plastic sandwich composites. According to the component's purpose, we used carbon fibers, aramid fibers and glass fibers as skin material and polymethacrylimide (PMI) foam and balsa wood as sandwich cores both bonded by an epoxy resin system. In addition to the carbon fiber parts, we manufactured the molds with a special epoxy tooling paste applied onto a polystyrene raw mold (Figure 3).

What are the benefits of these materials?

Our goal during the last two years has been to develop an ultra-lightweight car. However, we had to meet many constraints, regarding the driver safety and electric isolation, posed by the official competition regulations.

Focusing on the aerodynamic composite parts we used different fiber types to benefit the most from each individual fiber properties. To achieve the maximum lightweight potential, every part is designed as sandwich composite with carbon fiber as main skin material. Due to its high specific tensile strength and excellent adhesive properties it is the optimal fabric to minimize the weight of our sandwich structures. Using a special spread tow carbon fiber fabric for large surfaces, we could reduce the overall component weight even further compared to classic twill fabric.

For the solar panel, although carbon fibers have better mechanical characteristics in comparison to other fiber materials, we chose glass fiber as top layer material. However, since carbon fibers

**FIGURE 3**

Body manufacturing of the Sonnenwagen.

are electrically conductive, glass fibers proved to be the best solution to isolate the sensitive solar cells from all conductive material.

Concerning our drivers' safety, we utilized skin layers of hybrid aramid-carbon fiber fabric for the front surfaces and the entire cockpit structure of our car. Aramid fibers are widely known as Kevlar, an aramid fiber brand especially developed for bulletproof vests. Due to its high specific elongation at break aramid fibers are exceptionally well-suited to absorb the shock energy during an impact. Where carbon or glass fibers would break, aramid will only deform and thus protect the driver from hazardous projectiles (Figure 4).

I understand that Team Sonnenwagen Aachen aims to make advances in the field of sustainability, could you tell us how fiber composite materials can contribute to this goal?

Fiber composite materials change the way we design and manufacture in many different industries including automotive, aeronautical and nautical industry. Regarding sustainability, our most serious problem today is the fuel consumption and hence the negative consequences for the earth's climate. One simple

and obvious approach to reduce the fuel consumption is to exploit the full potential of lightweight design in every relevant industry. Fiber composite materials enable us to achieve the potential of lightweight design, due to their high specific tensile and ultimate strengths and anisotropic mechanical characteristics. With these opportunities, you can adapt the material's advantages to precisely match the structural requirements. Therefore, it is much more weight-efficient to establish fiber composite components and thus contribute to a more sustainable mobility.

Is there demand for new prototypes of fiber composite materials?

Fiber materials can be distinguished by their specific advantage in comparison with other types of composite fibers e.g. carbon fibers have the highest specific tensile strength; aramids high elongation at break ensures safety requirements and glass fiber works well as electrical isolation and has a very low price. Developing our solar car's lightweight composite parts, we had to compose multi-ply laminates of different fiber types as skin layers to include all necessary characteristics for each part. With new fiber



FIGURE 4

The Huawei Sonnenwagen in Australia.

types combining the advantages of existing composite materials it would be possible to reduce the weight even further due to a minimized number of laminate plies. Thus, new fiber composite materials could magnify the lightweight potential of composite structures even more.

Beyond the Team Sonnenwagen Aachen project, do you have any plans for the future?

After graduation next summer, I want to start working in the aeronautical or automotive industry. With the newly-gained experience and knowledge of aerodynamics and fiber composite design and manufacturing, I would like to continue to contribute to the development of sustainable mobility and spread the idea of energy independent mobility concepts.

What new materials and technologies are currently entering the fiber composite materials sector and what do you foresee on the horizon?

A new and fast-developing technology is 3D-printing, which obtains and increases its share in manufacturing processes over the last years. The newest trend in this area is the combination of 3D-printable plastics and composite fibers. A big disadvantage of producing composite parts nowadays is the necessity of a mold and the high individual effort in the manufacturing process. 3D-printable composite materials promise to combine the

rapid prototyping advantage of 3D-printing with the advanced mechanical characteristics of fiber composite materials. In my opinion this symbiotic relationship between a highly efficient manufacturing process and new advanced printing materials offers many auspicious possibilities to promote fiber composite materials throughout our everyday lives.

What are the major challenges facing the sector?

Today the composite industry mainly exists as a niche sector for prototypes or special and often expensive applications with few exceptions, e.g. for wind blade or surfboard manufacturing. The main challenges for the composite sector will be to simplify their complex manufacturing processes to increase their cost and work efficiency and to overcome technical limitations regarding repair and maintenance of composite parts.

While economic and work efficiency can be increased with scale effects and standard procedures, the field of repair and maintenance proves to be a difficult challenge. Looking at the aeronautical or automotive sectors for example, it will be crucial to develop and establish reliable standardized processes that can be performed all over the world. Unfortunately, there is a lack of standards and standardized methods nowadays for composite health monitoring and damage repair. Therefore, academical, industrial and public R&D facilities are the key institutions to overcome these technical limitations.

What's the next step for Team Sonnenwagen Aachen?

We want to establish our team in Aachen as a long-term project for all interested students and other enthusiasts. Since our team is mostly composed of students from the RWTH Aachen University and the University of Applied Science in Aachen we face a natural member fluctuation and are always looking for skilled people, who share our vision of sustainable mobility and are interested in joining us. We will try to compete at other solar car races, e.g. the European Solar Challenge in Belgium, and thus being able to spread our idea of a fuel-independent mobility even further.

How do you think that the research community, industry, manufacturers, and government best work together to enable new developments?

New fundamental developments can only be created, when all above-named parties work together as one. However, there is a lack of guidance from the governmental part in my opinion to

approach new developments in different sectors. A system of incentives for academical and industrial R&D facilities and entrepreneurial start-ups could encourage new developments. One key point of an incentive system would include a financial funding system, since nowadays most of academical R&D, especially in Germany, is based on third-party funds. Often this funding type is connected to a minimized risk tolerance, which automatically inhibits new developments.

Although funding and incentives are crucial for R&D, a direct and steady dialog between the industry and manufacturers on one side and the (academical) research community on the other is at least as important as the financial conditions. Connected clusters for R&D collaboration clusters on university campuses present an auspicious opportunity to encourage this dialog. Over the years, these clusters started to emerge slowly on R&D hot-spots all over the world. However, these specialized collaboration clusters and their overall benefits should be promoted even more among the industry and manufacturers to enable the full potential of a connected R&D approach.



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A new innovative SLS front air inlet is born

Veronica Negrelli, Matteo Levoni Bemposti, Emanuele Grotti

New materials enable engineers to create tougher, stronger, lighter, higher-performing components. This can be seen with materials such as composites for Selective Laser Sintering (SLS) technique: driven by demands from high performing sectors such as motorsports and automotive, the frontiers of material development will be pushed to even more extreme levels in order to reach even more successful results.

SLS composite materials must be suited to the application. The properties of any material become increasingly important as a product progresses from concept and functional prototyping to end use. CRP Technology's R&D department tackled the development of a new front air inlet for a Moto3 racing customer to solve space issues in the front fork area. It has been manufactured in WINDFORM® composite 3D printing materials by using the SLS Additive Manufacturing technique. Testing had shown that increasing air flow to the air-box improved the performance of the engine at every RPM range. This led the team as well as the engineers to conclude that they need to design a new track ready inlet. This design would make the air inlet longer, and bring the opening up to the front side of the fairing, in order to have a direct air flow with less turbulence.

Among the goals to be achieved was the need to avoid modifying the existing frame and the existing triple clamps. The design would have to fit the existing platform in order to test the on-track advantages and disadvantages of using this solution, and to make a direct comparison with the current standard inlet. The final decision to use the new inlet came from its behavior on-track with the key points being its performance and reliability. Engineers kept the current airbox with the aim to mount the traditional air inlet as well as the new one and to acquire data of the airbox pressure on track.

Through the use of reverse engineering, the original airbox was scanned and virtually assembled with the CAD system. This allowed the engineers to be able to create a new model of the air inlet by taking into account the amount of available space, and the constraints of the assembly of the current airbox and frame.

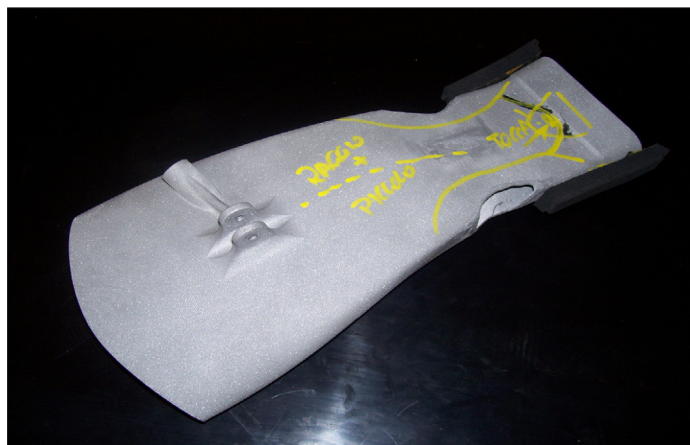
The reverse engineering technology represents a fundamental tool to recreate, design samples that are no more at disposal from the point of view of the industrial production, or to create pieces that are unique in the world. Reverse engineering represents a considerable advantage in the reduction of engineering timing in order to obtain high-quality products. Reverse engineering is also connected to product engineering because it can be used as the starting point for development of a product.

Once a first draft of the air inlet was developed, a prototype in WINDFORM® GF 2.0 (Composite polyamide based material reinforced with glass and aluminum) and SLS technique was created (Figure 1).

The first air inlet prototype allowed engineers to see if the design fitment was correct and suitable for assembly. It was revealed by the first design that some sections needed to be changed due to the lack of space available under the lower triple clamp. This problem is further complicated when the bike is cornering and under braking conditions.

To optimize the volume of the inlet duct under the lower triple clamp, the engineers adopted a creative approach and decided to use a portion of the duct in WINDFORM® RL, rubber-like composite material. This would be bonded to the main structure that was made out of WINDFORM® XT 2.0 (ground breaking carbon fiber reinforced composite 3D printing material) for evaluation in racing conditions. To facilitate this they also carried out a bonding test to study the characteristics of the final assembly.

The concept was to make the bottom part of the duct with WINDFORM® RL in the fork and triple clamp area, and then

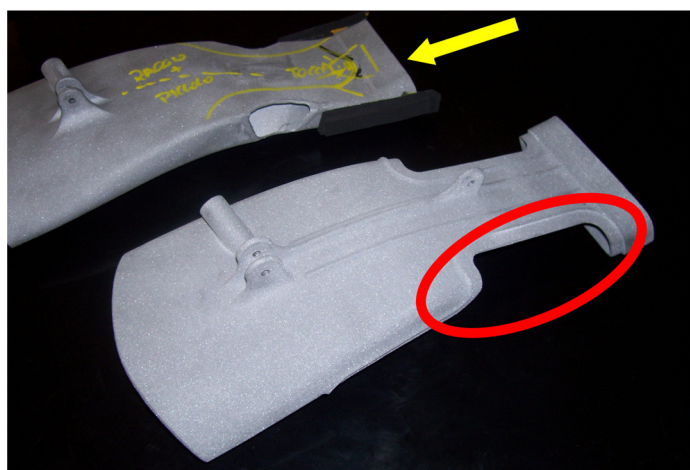
**FIGURE 1**

First prototype: the duct was mounted and required changes were marked. The flexible areas were adjusted to guarantee the minimum steering angle.

assemble this into the top part produced in WINDFORM® XT 2.0. This approach would allow good clear airflow on the straightaway sections of the course, and thus an excellent flow to the airbox. Under braking, the front fender could move up and collapse the inlet duct without any damages, due to the flexible material.

In addition, it was decided after examining the part that making the ducting flexible in the same area next to the front forks would offer an additional benefit. The engineers were able to maximize the duct volume because the maximum steering actions are only reached when the bike is pushed into the paddock by the technical staff. In this situation, the front fork can touch the inlet duct deforming it without any damages (Figure 2).

Before proceeding with the construction of the airbox in WINDFORM® RL and WINDFORM® XT 2.0, a second prototype was made in WINDFORM® GF 2.0. Once the second prototype was mounted the engineers noticed some changes to be made, especially in the front fork area.

**FIGURE 2**

Comparison between the two prototypes. First prototype: outlined in yellow changes to be made. Second prototype: the flexible area has been redesigned (outlined in red) in order to ensure the mobility of the steering.

The soft section was too short and the forks could touch the area of the duct near the bonding overlap when steering travel was checked from lock to lock position. It was also seen that toward the back of the flexible area, near the airbox, that the duct was very close to the front wheel in the maximum braking position.

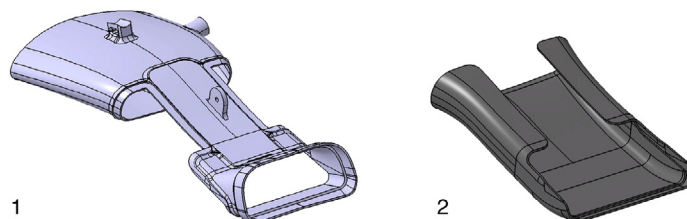
During testing it was determined that when the motorcycle was under severe braking, the front fender contact area on the duct in the soft part was too large. This situation, from the rider's point of view, was not good because during hard braking, the steering must be free from movements, as the rider might need to correct the trajectory quickly. The amount of input from the rider may be small, but it must occur very smoothly and too much contact of the front wheel assembly gave the impression of drag on steering. This affected the way the rider felt on the bike. The team and engineers decided to change the inlet by reducing the portion that would make contact with the fender to reduce drag perceived by the rider. The part made in WINDFORM® RL was enlarged according to the second test, and engineers and the rest of the team could get the correct fit for performance.

SLS technology uses a laser to harden and bond small grains of composite materials into layers in a 3D dimensional structure. The laser traces the pattern of each cross section of the 3D design onto a bed of powder. After one layer is built, the bed lowers and another layer is built on top of the existing layers. The bed then continues to lower until every layer is built and the part is complete. One of the major benefits of SLS is that it doesn't require the support structures that many other AM technologies use to prevent the part from collapsing during production (Figures 3 and 4).

In the final test version, WINDFORM® XT 2.0 was utilized in order to reduce the weight of the front and central part of the inlet, while the WINDFORM® RL material was used for the flexible part of the inlet. The two parts were bonded together after being produced (Figure 5).

WINDFORM® RL

Windform® RL is the first thermoplastic elastomer material within the Windform® family of materials for professional 3D Printing. It is a durable thermoplastic elastomer material with exceptional rubber-like distinguishing features. Its mechanical characteristics make it particularly suited for Additive Manufacturing applications requiring complex geometries, and where flexible characteristics are a key requisite.

**FIGURE 3**

From left: (1) Front air inlet – top part in WINDFORM® XT 2.0. (2) Front air inlet – bottom part in WINDFORM® RL.

**FIGURE 4**

Front air inlet (final version) after testing. Outlined in red the zone where the front fork touched the inlet duct.

**FIGURE 5**

Detail of the Front air inlet-bottom part in WINDFORM® RL (flexibility) after testing.

Flexible parts manufactured in Windform® RL and stiff parts in Windform® materials can be bonded together by epoxy resins or with mechanical joints. Choosing Windform® RL, customers will benefit from higher quality guaranteed by the experience and reliability of Windform® and CRP Group brands.

Windform® RL shows excellent durability and stability: It accommodates chemical and heat resistance and combines superior tear resistance with burst strength. It is perfect for functional rubber-like prototypes and parts (e.g. gaskets, hoses, and durable components). It is the material of choice not only for automotive and motorsport applications requiring flexibility, but also for athletic footwear and equipment, and for all parts requiring excellent shock absorption. It also allows for the manufacturing “soft-touch” items with non-slip surfaces e.g. handles and over-molded grips. Windform® RL is the material for simulating cast urethane, thermoplastic elastomer, rubber, and silicone parts along with complex production, F3 prototypes (prototypes to test form, fit, and function). Due to its mechanical properties,

Windform® RL assures high performance sealing power. Windform® RL Seal Infiltration is a method for strengthening, coloring, and sealing Windform® RL parts. Windform® RL Seal Infiltration enhances the strength at break and creates watertight barrier. It is available in a wide range of colors (Figure 6).

WINDFORM® XT 2.0 and the birth of fibers reinforces composite materials

The story of the evolution of the Windform® XT 2.0 fiber reinforced material is strictly connected to the birth of Windform family of materials, which has been an important turning point worldwide, a sort of “Evolution of Species” in the 3D printing field.

In 2005 Windform® XT was created, produced and launched on the market; a composite polyamide based material for SLS. Important progress has been made in the sector of additive technologies, with the development of Windform® materials, such as outgas tests for use in space, patch testing for the medical sector, fashion and design and testing of non-conductivity, expanding the use of these materials for additive manufacturing in all areas in which a highly durable material is required, offering the opportunity of being processed with high precision CNC machining.

In 2015, “the evolution” of Windform® XT was launched, the Windform® XT 2.0. Windform® XT 2.0 is a ground breaking carbon fiber reinforced composite 3D printing material known for its mechanical properties. It is particularly suitable in demanding applications such as motorsports, aerospace, and UAV sectors. Windform® XT 2.0 is an innovative material which replaces the previous formula of Windform® XT in the Windform® family of materials. Windform® XT 2.0 features improvements in mechanical properties including +8% increase in tensile strength, +22% in tensile modulus, and a +46% increase in elongation at break. The material allows for the creation of accurate, reliable, and durable prototypes and is perfect for functional applications. Windform® XT 2.0 is the material of choice for those working in the Motorsports (end plates and fences for F1 and IndyCar, alternator covers), Automotive (functioning cooling ducts, mirrors, headlight covers), Aerospace (UAV structures, small satellites, and spacecraft components), and Design fields. The material allows for fully functional applications, as well as test fitting or “proof of concept” pieces for testing on and off the racetrack.

WINDFORM® materials

Windform® materials are laser sintering materials for 3D printing and Additive Manufacturing.

Windform composite SLS materials were born from the study-research of the R&D department of CRP Technology in the late 90s. Thus, CRP Technology is the pioneer of additive manufacturing in Italy.

The SLS polyamide-based glass or carbon fiber reinforced Windform® materials can satisfy the needs of the international market of Additive Manufacturing and can guarantee originality, innovation, reliability, and mechanical performance. Windform® materials make it possible to fabricate high performance parts for wind tunnel applications, as well as fully functional

WINDFORM® RL	Test Method	US Unit	Windform® RL
GENERAL PROPERTIES			
Density		g/cm ³	0.45
Particle size			100% < 160 microns
Melting point	DSC	°F	374
MECHANICAL PROPERTIES			
Tensile Strength	UNI EN ISO 527	psi	217.55 - 609.16
Tensile Modulus	UNI EN ISO 527	psi	942.74 - 1160.30
Elongation at break	UNI EN ISO 527	%	130 - 160
Shore A Hardness	ASTM D2240		45 - 80

WINDFORM® RL	Test Method	SI Unity	Windform® RL
GENERAL PROPERTIES			
Density		g/cm ³	0,45
Particle size			100% < 160 microns
Melting point	DSC	°C	190
MECHANICAL PROPERTIES			
Tensile Strength	UNI EN ISO 527	Mpa	1,5 - 4,2
Tensile Modulus	UNI EN ISO 527	Mpa	6,5 - 8,0
Elongation at break	UNI EN ISO 527	%	130 - 160
Shore A Hardness	ASTM D2240		45 - 80

FIGURE 6

Windform® RL datasheets – US and SI Unity.

and beautifully finished parts for near endless applications. Currently there are seven Windform® materials: two carbon fiber filled polyamide-based materials; two glass fiber filled polyamide-based materials; Windform® GF 2.0, aluminum and glass fibers filled polyamide-based material; Windform® FX Black: High flexibility and excellent impact resistance even at low temperatures, exceptional resistance to repeated bending and torsion, consistency and behavior similar to polypropylene and ABS injection molded parts; the new born Windform® RL. All Windform materials can be CNC machined.

CRP Group profile

CRP Group is headquartered in Modena, Italy. The Group is made up of specialized companies (CRP Technology, CRP Ser-

vice, CRP Meccanica, plus its US-based partner CRP USA) dedicated to providing clients with the very latest technological solutions. With more than 45 years of experience in the world of F1 and more than 20 years of experience in Additive Manufacturing, CRP Group is distinguished by its know-how in specific application fields including but not limited to: automotive and motorsports, design, aerospace, UAVs, marine, entertainment, defense, and packaging.

In 2010 CRP Group decided to invest in the new field of sustainable vehicles by creating Energica.

CRP Group acted as a technology and financial incubator, and it is still today the lead investor of Energica Motor Company, since it has become an independent entity. CRP Technology is one of CRP Group's specialized companies. It offers part production for short- and low-run production, and prototyping services

with advanced 3D Printing and Additive Manufacturing solutions. As a material provider, CRP Technology develops, manufactures and sells its proprietary material Windform® for Laser Sintering.

Based in Mooresville, North Carolina, CRP USA is partnered with CRP group. CRP USA resides in the heart of the southern

industrial and manufacturing hub, and is surrounded by growing aerospace and motorsports communities. CRP USA manufactures on-car and wind tunnel components for racing teams and has taken this expertise to new heights to produce parts for the space, entertainment and automotive sectors using Windform® materials and Additive Manufacturing.

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New paradigm in advanced composite and nanocomposite design

Peter Samora Owuor, Amelia C. Hart, Jun Lou, Chandra Sekhar Tiwary, and Pulickel M. Ajayan

Advanced composite materials are characterized by lightweight and unusually high stiffness, strength, modulus, etc. [1,2]. Their application field keeps on expanding as cheaper methods for synthesizing raw materials are found. Composite materials are now found in virtually all facets of applied materials [3]. Unlike a few decades ago when their application was limited to small parts; for example spoilers, failings, bonnets, etc., currently a new generation of airplane fuselage and wings are completely made of high-performance fiber reinforced composites [4–6]. The inherent high specific strength, low density, chemical and corrosion resistance [7] make them ideal for future applications. Typically, composite materials consist of a combination of two or more materials that are mixed with an aim of achieving a specific structural properties [8]. An effective composite should be able to optimize the properties of the individual components as one.

In fiber reinforced composites, the fiber is the primary load carrying element while the matrix supports the fibers and aid in load transfer apart from providing environment resistance to the whole composite material [9,10]. The interface between the fibers and matrix is very crucial in composite design [11,12]. This interfacial region plays a critical role where it determines final strength in composites/nanocomposites [13]. The bonding behavior at this region can determine whether the reinforcement phase such as carbon fiber, glass fiber, carbon nanotubes, silicon dioxide [14], graphene oxide [15], etc. will complement the final material properties. Improving the interfacial region is the main reason why fiber sizing is done to increase its affinity between fibers or reinforcement with matrix. Here, we are proposing two methodologies (interconnected or junctions CNTs and Silicon-CNT) which can greatly improve on the interfacial bond between the reinforcement and matrix.

Interconnected or junctions CNTs (iCNTs) covalently linked to form networks [16–18] are theorized as the best way to ensure efficient load transfer within polymer matrices. Interconnected CNTs [19–21] (iCNT) are synthesized by the chemical vapor deposition (CVD) whereby heptagons and pentagons are introduced in the hexagonal carbon lattice. Most of these intercon-

nected CNTs like the Y-junctions are mainly used in electronic devices. Junctions in CNTs can achieve high stiffness and better energy transfer in CNTs foams [17] attaining a stiffness of more than 6000 kNm^{-1} . The different junctions are used to reinforce polycarbonate matrix. The junctions are formed as result of growth and nucleation in CVD (Figure. 1a). Specifically, CNTs are first grown on the substrate from the first catalyst. To form the junctions, the second source of catalyst is then introduced (carbon and iron) which acts like nucleation sites within the first grown CNTs. Continuous flow of iron and carbon source result in high number of nucleation sites forming many junctions such as X, Y, etc. [17].

On the other hand, to synthesize silicon dioxide fibers coated with carbon nanotubes (CNTs) which are later converted into nanowires, the CNTs are used as template. In this method, a water-assisted CVD is used where the fibers are dipped in the catalyst. The ‘fuzzy fiber’ of dense, curly and curvy CNTs is achieved by catalyst optimization and growth time (Figure. 1b). For high temperature application however, the silicon/CNTs are converted into SiCNT/NWs. This process is achieved by immersion of the fiber in Si nanopowder at very high temperature. We next discuss the mechanical properties as result of these modifications on CNTs and Silicon fibers.

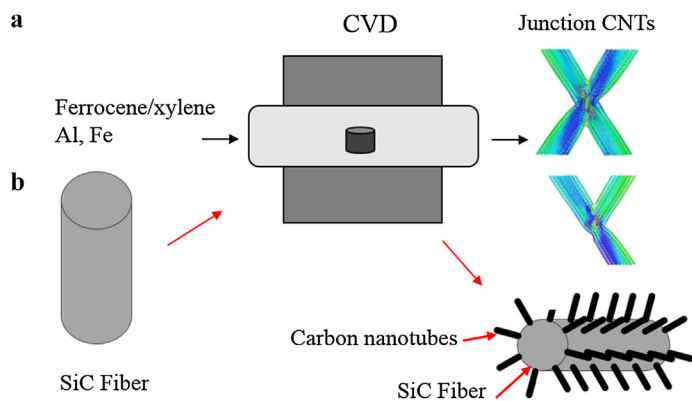


FIGURE 1

Synthesis of junctions and SiC-CNT fibers (Source: Ref. [22] with permission from (2016) John Wiley & Sons).

To grow junction CNTs, the first CNTs are grown on the substrate and a continuous supply of CNT source is introduced which act like nucleation points with the first CNTs resulting in covalently connected different types of junctions like X and Y shown in Figure 1a. Growing CNTs on SiC fiber is also done in a CVD, where the fiber is dip-coated in CNT precursors and subjected to high temperature to form a forest like of CNTs on the surface of the SiC fiber as depicted by the schematic in Figure 1b.

Figure 2a and b shows an artistic representation of a nanocomposite reinforced with conventional (a) and junction CNTs (b). The selected matrix was polycarbonate (PC). The nanocomposites are made by first exfoliating the CNTs into PC solution by magnetic stirring. The mixed solution is then casted on glass slides into thin films. The van der Waals forces normally lead to agglomeration resulting in poor mechanical properties of the nanocomposite. Lack of junctions as shown in Figure 2a lead to the polymer molecules sliding over the CNTs, meaning poor

load transfer. Contrary to conventional CNTs, junctions CNTs tend to prevent such sliding as the polymer molecules wrap themselves within these junctions (Figure 2b). The covalent junctions are also important in stress or load transfer and distribution in the polymer matrix [22]. Uniaxial stress-strain curve shown in Figure 2c reveals the high modulus and strength of junction CNTs compared to conventional CNTs. The two nanocomposites exhibit the typical linear regime at lower stress as the load increases. The high modulus and strength as theorized before could be due to the junctions forming interconnected networks in the polymer matrix. These networks are important in load carrying and distribution in the polymer resulting in a homogeneous nanocomposite in mechanical response unlike conventional CNTs. Recently in our group we have shown multifold improvement in stiffness as a result of such junctions [23]. However, very little was known of the load distribution and transfer due to this junctions. Therefore probing the mechanism behind such an improvement is important for future design of these advanced nanocomposites. Detail analysis of the scanning electron microscopy (SEM) shows the bridging of cracks because of junctions in CNTs (Figure 2c). Furthermore, when used as reinforcement, the junctions CNTs carry both shear and compression loads on the junctions. This is important as conventional CNTs will only carry one type of load hence the lower mechanical properties observed.

To rank the effective rank of different types of junctions, a model is developed in atomistic molecular dynamics simulations and shear stress applied in selected junctions like , X, and X-junctions. Total axial force on each junction is plotted with axial strain and we find that straight CNT with no junction, the applied force is distributed uniformly in the whole nanotube. For the CNTs with junctions however, high stress concentration is observed in the junctions confirming the assumption of importance of the junctions in the polymer matrix. Tangential shear force at the edge of each junction shows a higher effective shear modulus compared to un-branched or conventional CNTs. This could be an effective method in future to design multifunctional nanocomposite. For instance, CNT are known to be excellent conductors hence this approach may result in conducting network in the polymer matrix and the conducting can be utilized as health monitoring [22].

SEM images of the fiber as received shows a smooth surface without any cracks or defects (Figure 2e). Once received in this form, the fibers are soaked in iron solution and subjected to heat for the growth of CNTs. Homogeneous distribution of iron particles on the fiber surface is crucial to grow uniform CNTs on the surface. As the growth continues, the CNTs average length as well as the density increases. As shown in Figure 2f, there is a well-distributed CNTs forests on the surface of SiC fiber. It is importance to mention the growth time have an effect on the CNTs growth and for this work, the optimum was found to be five hours. The morphology of SiC-CNT shows entangled mass of long CNTs which can be important to anchor on other SiC-CNT fibers which increases greatly the interfacial strength between the fibers and matrix. An in situ compression and friction test between SiC-CNTs fibers is used to measure lateral force required to overcome static friction between the fibers. The SiC-CNTs fibers exhibit larger lateral force required to separate the

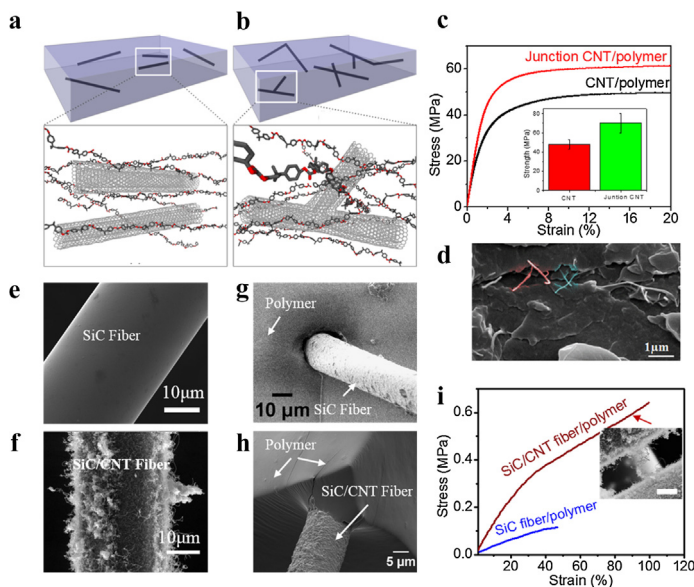


FIGURE 2

Mechanical response (Source: a, b, c, d – Ref. [22], John Wiley & Sons; e, f, g, h, i – Ref. [24] American Chemical Society).

fibers unlike pure SiC fibers which slide over each other easily. Compression test on the individual CNT shows their complete recovery after a load of 4 μm due to high inherent elasticity. To test the macro-scale mechanical behavior, the fibers were embedded in polydimethylsiloxane (PDMS) matrix and a tensile test performed. For pristine SiC-polymer composite, there is little or no adhesion between the fiber and the matrix. A clear hole surrounding the fiber can be seen from an SEM image (Figure. 2g). The SiC-CNTs fiber however, shows excellent bonding with the matrix. There are even cracks on the matrix rather than fiber pull out (Figure. 2h). Such a strong interfacial bond can only be achieved as a result of inter-locking of the CNTs within the polymer matrix. From the stress-strain curve in Figure. 2i, SiC-CNTs fiber composite have very high modulus as well as strength in comparison to SiC composite [24]. Failure mechanism of the SiC-CNTs/polymer can be discerned from the stress-strain curve. In low stress values for SiC fiber/polymer, the polymer matrix will transfer the stress to the fibers but as the stress increases, de-bonding of the fibers from the matrix will occur owing to the poor adhesion of the two at the interfacial region. However, for the SiC-CNTs the forests of CNTs with their high aspect ratio will form interlocking points with polymer matrix. The interlocking mechanism kicks off around 30% strain as shown in the inset of Figure. 2i. The interlocking of the CNTs to the polymer is so strong resulting in a very steep modulus increase compared to SiC fiber. This can be assumed as 'ideal' composite where the fibers perform more than 90% of their load carrying capacity. From this observation, we conjecture that having strong fiber in a composite is important but if the interfacial bond between this fiber and matrix is weak, it result in poor composite with unsatisfactory mechanical properties. This observation can be observed in most of the conventional composite materials where more often, fiber pull out is the dominant failure mechanism. In such type of composites, as a result of poor interfacial strength, the matrix is subjected to unnecessary high stress which cannot be distributed evenly to the fibers and premature failure will normally occur. Apart from CNTs, other one dimension nanomaterials may be able to offer same effect but CNTs are much better due to their ability of forming strong covalent bonds with SiC fibers. Even under high temperature as performed on the thermogravimetric analysis (TGA), the SiC-CNT appear to retain their thermo-stability associated with SiC. Further conversion to nanowires can be done to design even stronger and tougher silicon carbide carbon nanotubes nanowires (SiCNT/NW). This can be done with a simple two-step process where CNTs are grown first, then converted to nanowires. Such fibers are needed for high temperature application in ceramics matrix where the temperature can exceeds 1500 $^{\circ}\text{C}$. With such high temperature application it is necessary to prevent oxidation and these fibers can prevent that.

Figure. 2a and b shows an artistic representation of nanocomposites reinforced with conventional CNT (Figure. 2a) and junctions CNT (Figure. 2b). The polymer chains are seen wrapping themselves in the junctions resulting in high modulus and strength nanocomposites as shown in stress-strain curve (Figure. 2c, inset). Scanning electron microscopy image shows the bridge-like effect of various junctions (Figure. 2d). Figure. 2a–d) Iso

shows the smooth surface of pristine SiC fiber (Figure. 2e), CNT forests grown on the SiC fiber by CVD (Figure. 2f). Fibers pull out of the SiC fiber from a polymer matrix under tension (Figure. 2g), strong bond between the fiber (SiC-CNT) and polymer matrix where the matrix breaks before the fiber pull-out (h). Stress-strain curve of the composite showing high strength and modulus of SiC-CNT composite and interlocking mechanism of CNTs (i, inset scale bar 3 μm).

In general, judicious designs are required for the multifunctional composite materials with tailored properties. The interfacial region between the reinforcement and the matrix will still play a crucial role for future material design; this can be done by physical methods as discussed here in addition to chemical ways. A combination of the two should also be pursued in order to realize composite with excellent materials.

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New developments in carbon fiber

Matthew Smith

Choice Roofs

Carbon fiber, or simply carbon for short, goes by many different names and acronyms: carbon fiber reinforced polymer (CFRP), carbon fiber reinforced plastic (CRP) or carbon fiber reinforced thermoplastic (CFRTP). It is a composite material, a type of a fiber-reinforced plastic, and it is used in industries and areas whose products demand high levels of strength-to-weight ratio. This means that carbon fiber is extremely light but at the same time extremely strong, rigid and durable. Some of the areas and industries where those characteristics and features are very needed and sought after are aerospace, civil engineering, automotive, marine, construction, and many others are also starting to discover the good, useful and attractive uses of carbon fiber.

What is carbon fiber?

Carbon fiber is a composite material and a type of fiber-reinforced plastic. To better understand carbon fiber, it should first be clarified what composite material means as well as what fiber-reinforced plastic is, explaining some of their main features, describing some of the most important parts of their formation and production, and giving an overview of the range of their applications.

Composite material

Composite material, or as it is also known, a composition material, or simply a composite, is a material made out of a combination of two or more different materials that form one structure. This new material will have different properties and characteristics than the individual originals that were combined. Interestingly, even though a new and different composite material is formed, the individual components are still visible as they do not blend and mix with each other. The reason that composite material is produced is that it will result in better and superior properties, both physical and chemical, to the properties of the individual components.

The new composite structures are preferred and widely used for many reasons – they are lighter, stronger and significantly less

expensive than some traditional materials. Composites can be stronger and bear much more weight than some of the typically strongest metals, such as steel, but at the same time weigh much less, five times less than steel.

Composites have been used since ancient times, for thousands of years. For example some of the first composites were mud bricks, used as building material, or even straw mixed with mud which makes for a very strong material. Concrete is also one of the ancient composites. Historically, it was made out of stones and gravel, mixed with cement and sand, also giving a very strong composite structure. Later, in more modern times, including today, concrete has been upgraded by adding metal rods or wires to it, which in turn increases its ability to bend and stretch when necessary. Today it is called reinforced concrete and it is one of the most commonly and widely used composite materials. The first modern-day composite material used was fiberglass, which is still very familiar and commonly used. Glass is stiff and strong, but due to the fact that it is also very brittle and prone to breakage, it has been slowly replaced with carbon fibers. Other types of modern day composite materials include reinforced plastic, such as fiber-reinforced plastic, metal composites and ceramic composites.



Figure 1 Fiberglass (Source: https://www.fiberglasswarehouse.com/blog/choosing_which_fiberglass/).

Composites are most commonly made out of two materials, but there can be more. When it comes to the materials, or better yet, the constituents of composite materials, there are two main categories: the matrix or the binder, and the reinforcement. Each category is equally important, so there should be at least one material functioning as the matrix and one functioning as the reinforcement. The matrix is normally a form of resin, and its role is to protect the reinforcement materials by surrounding them and keeping them in their desired position, bonding them together. The reinforcements, on the other hand, are used to strengthen and stiffen the matrix, using their own unique properties to fortify the matrix and enhance its properties. The unique quality of reinforcements allows them to be shaped, cut and placed in many different ways in order to enhance and produce the desired properties as the end result, in the composite. Since there is an array of possibilities and varieties when it comes to combinations of matrices and reinforcements, the producer or designer can choose any that suits them and their needs and that will produce optimal end results and products.

Matrices can be organic – polymers (fiberglass, carbon fiber, Kevlar), bitumen, mud; or inorganic – concrete, metals, ceramics, glass. Reinforcements are most commonly in the form of fibers, and some of the most common are glass, carbon, cellulose and polymers. Other types of reinforcement include aggregate (for concrete) and steel bars (for reinforced concrete).

Composite materials are usually made by molding, since they have to be formed into a shape, and there is a variety of molding methods, depending on the end-product requirements. During the process of molding, the reinforcement material is placed into the cavity of surface for molding, and the matrix can be introduced either before or after that, depending on the requirements of the end-design.

Fiber-reinforced plastic

Fiber-reinforced plastic (FRP), also called fiber-reinforced polymer, is a type of composite material. The main constituents of FRP are matrix and reinforcements, as with any other composite. Here, the matrix is a polymer which is most commonly an epoxy, vinyl ester or polyester thermosetting plastic, but phenol formaldehyde resins are still being used. When it comes to the reinforcements, their function is carried out by the fibers and they are usually carbon, glass, basalt or aramid, even though other types, such as wood, paper or asbestos, are still being used sometimes.



Figure 2 Fiber-reinforced plastic. (Source: Pixabay.com).

The main areas of usage of fiber-reinforced plastics are usually aerospace, marine, construction industries and marine, and it can also be found in ballistic armor.

FRPs are very widely used due to their high-quality, useful and advantageous properties, which can be unique and designed according to the desired end-product due to many possible combinations and types of polymers and fibers. Some of the most valuable properties of FRPs include their extremely optimal strength-to-weight ratio, which means they are very low in weight and high in strength, and can therefore even be used to replace some metal parts on certain objects. For example in automotive industry they can replace metal parts in cars, since they are as strong as metal but much lighter, decreasing the overall weight of the car and the fuel consumption. They also have significant electrical properties, they are environmentally resistant, resistant to corrosion, provide thermal insulation, and are very stable, resistant, strong and cost-effective when it comes to their production.

Fiber-reinforced polymer is developed through two processes – step-growth polymerization and addition polymerization. Through these processes, the original plastic material, the matrix, is reinforced by strong and stiff fibers, and the end-product is an FRP, higher in both strength and elasticity.

Carbon fiber

Carbon fiber, most commonly referred to as CFRP, is therefore a composite material, a fiber-reinforced polymer, where the reinforcements are carbon fibers. The matrix or the polymer that functions as the binder is most commonly a thermoplastic one, usually an epoxy, but it can also be polyester, nylon and vinyl ester. Carbon fiber reinforced polymers consist of only two elements, so their properties will depend only on those two elements and their type, the matrix and the reinforcement.

Carbon fibers are very stable, stiff and strong, as is the case with other fiber-reinforced polymers, but they are also distinctively very thermally stable and can withstand a wide range of temperature. This is why they are most commonly used FRPs in aerospace and are usually connected with a range of space applications. They are also very lightweight which also gives them advantage over metals, since reducing weight is always a necessity, especially when it comes to space and aircraft applications. They are highly electrically conductive, which can be both an advantage and a disadvantage, depending on how, where and to which purpose they are used.

The main element of a CFRP is a carbon fiber, which functions as a reinforcement. Carbon fibers are produced from a polymer which can be a polyacrylonitrile (PAN), petroleum pitch or rayon through certain chemical and mechanical processes. After the fibers are made, there are several methods of creating CFRPs out of polymers and those fibers, and some of them are: molding, vacuum bagging, compression molding, and filament winding.

Carbon fibers' widest and most common applications include the aerospace engineering, automotive engineering, civil engineering and productions of sports goods.

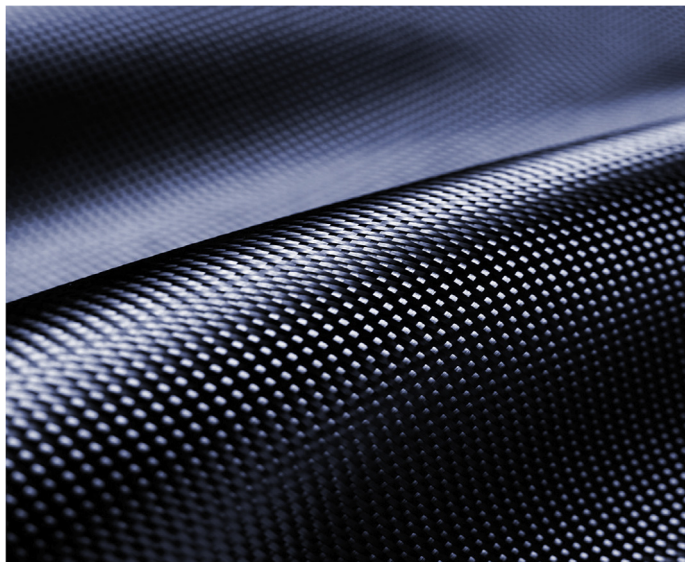


Figure 4 Carbon fiber curves (Source: https://www.commonswiki.org/wiki/File:Carbon_fiber_curves.jpg).

New developments in carbon fiber

New and advanced forms of FRPs are growing every year and their applications is widening proportionally. Composites are being applied in a variety of areas and industries, as their application is becoming more advantageous and valuable than ever.

When it comes to the developments of carbon fiber reinforced plastics the developments are also not lacking. There are some new and innovative qualities with regard to the performance of the resin systems, the polymers, as well as with the reinforcements, the carbon fibers and their new styles and types.

A key development is carbon nanotubes and nanoparticles, which already have many applications and can potentially have even more. Carbon nanotubes (CNTs) are valuable and widely used in industries and areas such as nanotechnology, electronics, optics and other fields of materials science and technology. They are shaped in the form of a tube; they are cylindrical and are measured on a nanometer scale. For comparison reason, one nanometer is about 10,000 times smaller than a human hair, which means it is a one-billionth of a meter. One carbon nanotube can be as small or as thin as a few nanometers.

Carbon nanotubes can have different structures, length, thickness and a different amount of layers. According to the number of layers there are two main types of CNTs – single-walled nanotubes (SWNT) or multi-walled nanotubes (MWNT), where a single-walled has only one layer (one wall) and it can be compared to a piece of straw, and the multi-walled can have many, it can be a collection of up to one hundred walls or tubes.

Most common application of nanotubes is structural reinforcement. They are extremely strong, durable and stiff, and on the other hand extremely lightweight – lighter than any other composite due to their nanostructure. When compared to steel, for example, they are a hundred times stronger and around six times lighter. Other important and valuable properties include increased flexibility which means that they can be very easily

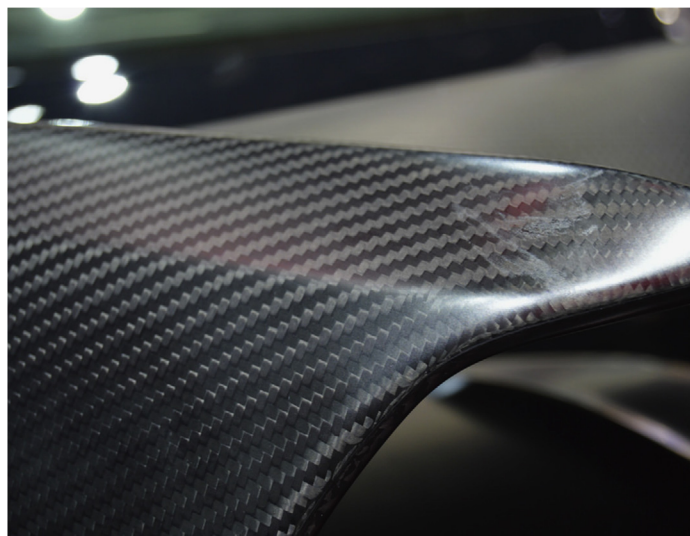


Figure 3 Carbon fiber (Source: <https://www.flickr.com/photos/128326674@N06/24322793889>).

added to any other material. One of their most important properties is that they can be highly electrically conductive, which has a lot of potential for future developments where nanotubes may even replace metal wires. They can conduct electricity even better than copper. On the other hand they can also have semi conductive properties, depending on the rolling angle of their tubes and their distance, which can have valuable applications in the future production of computer chips, for example.

Similarly to their electrical conduciveness, carbon nanotubes can, in a way, work on both sides of thermal insulation. Along the length of the tubes they are expected to be highly thermally conductive and this property is known as ballistic conduction. However, across the tubes, lateral to their axis, they are very good insulators.

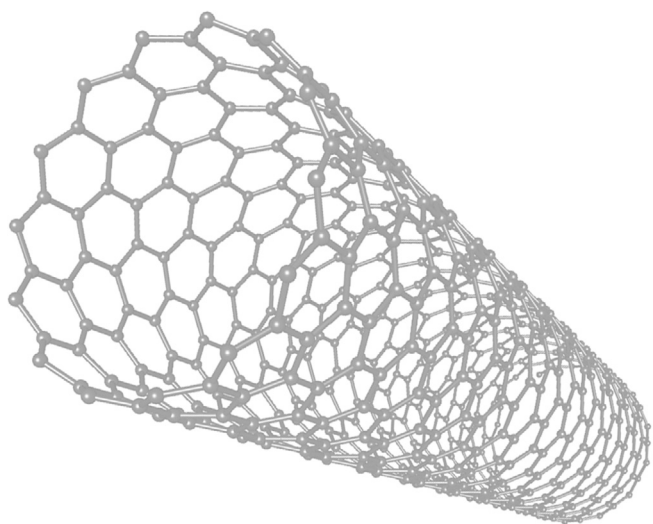


Figure 5 Carbon nanotubes (Source: <https://www.flickr.com/photos/ajc1/13560499845/>).

Current and potential applications of CNTs

Carbon nanotubes, as already mentioned, have their main and most wide application in structural reinforcement. They are usually used in a mass, the so called bulk nanotubes. This is not the best use of the nanotubes' potential, but currently it is mostly limited to it. The bulk nanotubes are fairly disorganized and fragmented so they do not have the highest possible strength that they could potentially achieve. Bulk carbon nanotubes are mostly used as composite fibers in polymers in order to enhance some of the properties of the end-product, such as electrical, mechanical and thermal.

Different companies have also found some different applications of CNTs, so they are being used in the production of bicycle components, components for maritime vessels, as well as in the production of stronger composite materials used for wind turbines and different sports products. Other less spread use of nanotubes is tissue engineering, where they are used in the production of bone growth as scaffolds.

When it comes to the potentials of carbon nanotubes, their most promising application would be in the nanotechnology engineering. They are very strong and flexible, which makes them useful in controlling other nanostructures. And due to their semi conductive properties, as was already mentioned, they can be the future of computer chips.

As with probably all new developments, inventions and technologies, there is a lot of research to be made and many aspects and properties to be discovered, both the positive and the negative, and only then can those new developments achieve their full potential. The process is usually very long, the research and discoveries extensive, and the same is the case with carbon nanotubes.



Biocomposites for interior facades and partitions to improve air quality in new buildings and restorations

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Composite materials are revolutionizing architecture, since they allow the replacement of traditional materials and provide more options allowing higher design freedom to designers. Durability is one of the key factors in the development of composite materials in the construction sector. The use of biocomposites will allow us to improve the indoor air quality of houses and therefore personal health. It will also increase the thermal and acoustic insulation of houses and control the breathability of construction systems.

Composites are revolutionizing architecture

The plastics market, in general, and the composites market, in particular, is on the rise, with good growth prospects in the immediate future, and more importantly, in the long term. The possibilities that composites offer in the field of weight reduction, design, ease of assembly and low maintenance, have resulted in their introduction in all spheres of modern life.

Currently, composite materials are revolutionizing architecture. Their application has allowed the replacement of traditional materials and the provision of more options allowing higher design freedom to designers. Among the advantages that plastic materials and composites offer in different applications of the construction sector, we highlight their weight reduction, design, ease of assembly, low maintenance, as well as their better behavior against corrosion. Up to now, composite materials have been used in secondary structures or as supporting structures as domes, but recently, some architects and engineers have developed complex solutions to satisfy creativity in the design of singular buildings and constructions. These applications are possible thanks to the use of plastics and composite materials and their advantages, such as their light weight and ability to obtain complex designs.

Composites of glass fiber-reinforced polymers can be used in different types of infrastructures, such as pedestrian walkways, bridges, reinforcements for bridges and construction of façades. Different processes can be used to produce composite materials adapted to different raw materials, the required product geometry, the properties, the processing time and the cost. The pultrusion

process is a continuous manufacturing process of profiles of composite materials, where continuous fibers are used as a main reinforcement. Different resin systems can be used with the aim of obtaining the desired final properties. The design flexibility and the possibility of combining different materials are the main advantages of pultrusion. The properties at the structural level of this kind of materials are almost unlimited. In the pultrusion process, fibers are impregnated with a thermosetting resin and introduced in a heated mold, where the curing process takes place. Different combinations of laminates are possible by using reinforcements as roving, mats and fabrics. The final profiles are cut to the required length at the end of the pultrusion line. [Figure 1](#) presents the pultrusion equipment available at AIMPLAS' facilities.

Case studies in composites

The congress center of Badajoz (Spain) is an example of a building where composite materials were used. It has a surface area of 15,000 m² and consists of a circular façade built with GFRP (Glass-Fibre Reinforced Plastics) profiles, providing visibility and transparency to the main cylindrical building. The circular façade has a diameter of 75 m and is 14 m high. It contains more than 12 km of profiles made of composite materials ([Figures 2, 3](#)).

Another example of the use of composite materials in the construction sector is the restoration of a building on the seafront in the Marina Real Juan Carlos I, in Valencia, where the business school Edem, Lanzadera, is located. The aim was to renovate the building's image, control solar radiations and their energy

**FIGURE 1**

Pultrusion equipment at AIMPLAS' facilities.

**FIGURE 2**

Congress center of Badajoz.

**FIGURE 3**

Pultrusion profiles.

**FIGURE 4**

EDEM, Marina Real Juan Carlos I, Valencia.

efficiency. Another aspect considered was to optimize its durability in an aggressive environment such as the seafront. For this project, approximately 7000 m² of coating panels and more than 15,000 m of slats and sunshades made of composite materials have been used (Figure 4).

This project recently won the JEC Innovation Chicago Awards 2017 in the building category. This is one of the most important prizes in composite sector, recognizing the effort of the partners involved in the project (Owens Corning, (France), Gazechim Composites Iberica, S.A. (Spain), Polymec SI (Spain), ERRE Arquitectura (Spain), Miraplas, S.L. (Spain), RTM Bey Consultant (Spain)).

The construction industry as a whole needs an update in terms of legislations and sustainability in order to adapt itself to the new demands of the occupants. This can be applicable in sectors, new buildings and restoration, also taking into consideration the need for energy-efficient buildings.

Biocomposites to improve indoor air quality

As abovementioned, composite materials offer solutions that can boost the needed update in the construction sector: light weight or mass, durability, corrosion resistance, design flexibility, efficiency in construction, properties as insulation, good specific properties, possibility of obtaining panels for restoration, among others. If we go a step further, we observe that biocomposites can offer us the same solutions as composites, but with lower environmental impacts, reduction of CO₂ due to the use of natural fibers and bio-resins, use of materials from renewable sources, healthier construction, as well as higher quality living conditions.

Biocomposites are those materials formed by natural fibers or bio-resins. The most used natural fibers are jute, hemp and kenaf. Among the bio-resins we stress polyurethane resins, epoxy or vinylester, 100% bio-resins such as furanic resins and bio-thermoplastics. Usually, the bio content of a resin is between 10% and 100%.

Indoor air quality and the emissions of construction materials are a major challenge for scientists, the industry, and consumers,

since traditional construction materials release contaminants such as VOCs (Volatile Organic Compounds) like formaldehyde, acetone and benzene, particles such as organic compounds, heavy metals and spores, and fibers (plants, synthetic fibers from yarn materials, nanofibers). The project OSIRYS is working on the development of new, ecologic and innovative construction materials from which it is intended to provide a healthier indoor environment by developing a holistic solution to the current emission challenges that the construction industry must deal with. In addition, special attention has been paid to additives, especially flame retardants, in order to comply with legislation, cost, process ability, and the performance ratio.

The OSIRYS project aims to improve indoor environmental quality and energy efficiency by developing forest-based composites for façades and internal partitions to be applied in retrofitting and construction of new buildings. It is expected that the raw material of each construction element is higher than 75%. We think that our strategy to achieve that can be divided in two ways. Firstly, we are replacing the contaminant contemporary construction materials and products based on renewable sources. Secondly, since we understand that all the hazardous materials cannot be replaced overnight, we are developing photoactive compounds available to absorb VOC, formaldehydes and other chemicals, and destroy bacteria in relatively low artificial light levels. For that reason, the OSIRYS project is structured around the production of four products: a curtain wall system, a multilayer façades system and interior windows and partitions. As the main finishing element of a building, with the development of these products, it is intended to achieve a great impact in indoor air quality and the market of building construction. The consortium tasks include the development of new materials such as multifunctional photocatalytic cladding, light foam panels to replace plasterboards, flame-retardant cork panels for sound absorption, flame-retardant biocomposites panels and weatherproof biocomposites panels for exterior claddings, high mechanical-performance biocomposites profiles, and bio-adhesives allowing the fusion of different components. The combination of all these materials and their use in products, as well as their marketing, require innovation. Some examples of final products are fiber foamed board, biocomposites panel reinforced with extruded fiber, thermosetting biocomposites profile, flame-retardant cork insulator, adhesives with low content of VOC (Volatile Organic Compounds), biocomposites cladding panel (Figures 5–8).

At the JEC World 2017 fair in Paris, we presented the prototype made within the framework of the OSIRYS project. The exterior panel is manufactured with jute and bio-based epoxy. The multilayer module is the nucleus of the system and contains bio-foams, flame-retardant thermoplastic sheets and pultruded profiles that provide the thermal, acoustic, flame-retardant and mechanical properties required. The interior finish is bio-based and has a cladding coating that provides significant improvements in indoor environments (Figure 9).

One of the most important aspects of the OSIRYS project is to assess and to verify the technical performance of new biocomposite materials based on forest biocomposites, and the best way to test this is to apply it on real construction sites. For this reason, and considering the European climate, the project will



FIGURE 5

Prototype of foamed plates.

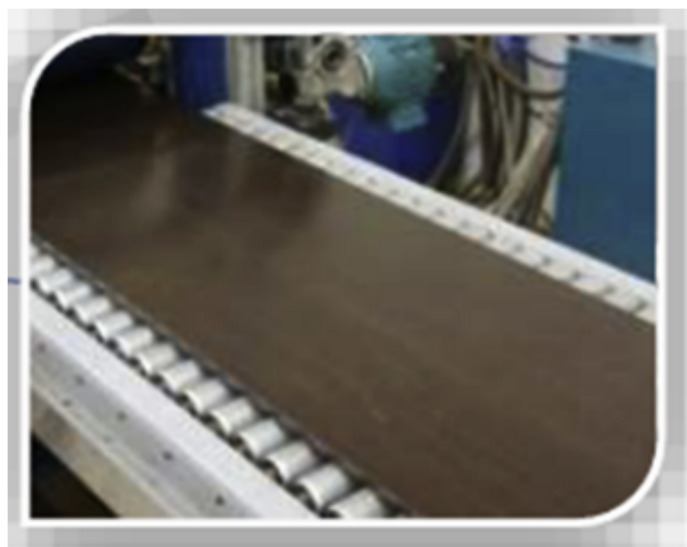
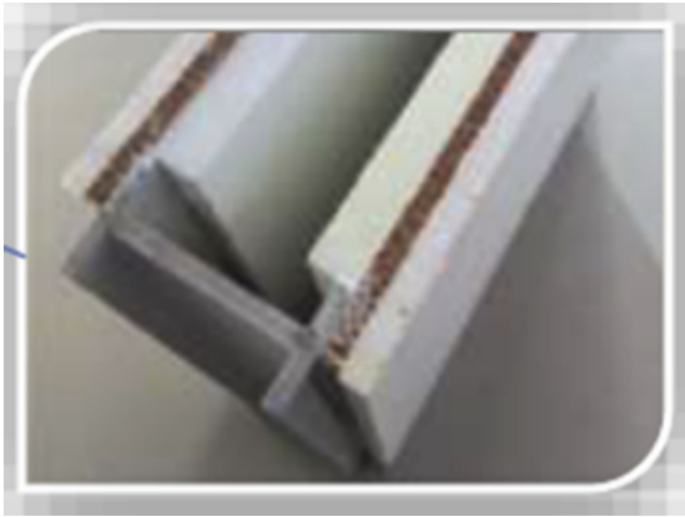


FIGURE 6

Biocomposite extruded panels reinforced with fibres.

provide two demos, one in northern Europe and another one in southern Europe. The southern Europe demo building will be developed by VISESA, the public housing corporation of the Basque Government, which is in charge of most of the social housing developments in the Basque Country. The OSIRYS project's biocomposite materials are planned to be used in façades and in interior partition walls and monitoring activities are planned to compare air quality and emissions standards, and to calculate the contribution of OSIRYS' products to a healthier indoor environment. Construction works started in May 2016 with site preparation and foundations, and is currently in progress (Figure 10).

The Tartu demo site for the OSIRYS project is going to be Tartu Mart Reinik Gymnasium's football stadium. The stadium

**FIGURE 7**

Thermosetting biocomposites profiles.

**FIGURE 8**

Prototype of biocomposite cladding panel.

building is a brand new 250 m² building that is intended to improve conditions at the stadium. The stadium building is being constructed mainly from the OSIRYS' project materials, including curtain wall elements, multilayer façades and indoor

**FIGURE 9**

Prototype of OSIRYS project.

**FIGURE 10**

Social Housing block in San Sebastian, Spain (Osirys Demo Building).

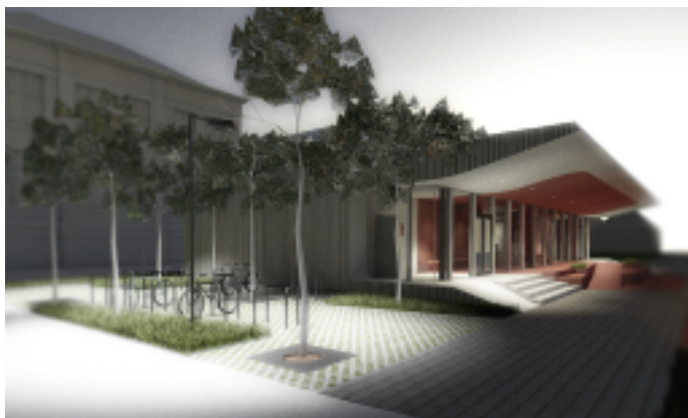


FIGURE 11

Stadium building in Tartu, Estonia (Osirys Demo Building).

wall elements, to improve indoor environmental quality and energy efficiency by using forest-based biocomposites and products (Figure 11).

Potential of biocomposite products

Products developed within the OSIRYS project present high potential and can be introduced in vast range of applications. The OSIRYS project has developed technology to improve indoor environmental quality and energy efficiency by using forest-based biocomposites and products for façades and interior partitions. These new technologies can then be applied in retrofitting and new building construction. The most promising products are

pultruded profiles and infused cladding panels based on bio resins and reinforcement made of fused natural and glass fibers. FRP products are known for their extremely high mechanical properties as well as significantly low thermal conductivity. Components comprising bio materials preserve the same properties. In the OSIRYS project pultruded profiles are used as a structure for external wall elements (multilayer wall and curtain wall modules) and for internal partition walls. In future applications engineers can consider the use of pultruded profiles in other structures including balconies, staircases, and footbridges. They can be used everywhere where high mechanical strength is required. As for infused panels, the most valuable implementation for this element in the construction sector is external cladding. Their light weight, durable structure and unlimited forming possibilities favor the use of infused elements in this application.

Another innovative material developed in the OSIRYS project is fire retardant panels produced through an extrusion process using bio-HDPE and gypsum board waste. In the project, they will be used to cover external layers of multilayer wall modules to improve fire retardant properties of buildings. Architects will receive material with which they will be able to use their imagination and create new shapes which earlier were hardly achievable with currently used façade materials. More information about the project and the consortium can be found online at <http://osirysproject.eu>. This project has received funding from the European Union Seventh Framework Programme for Research, Technological Development and Demonstration, according to the grant agreement 609067.



Plastic products for construction: The importance of CE marking

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CE marking means European Conformity and it is the evidence provided by the manufacturer that the product meets the minimum legal and technical requirements in terms of safety in the European Union.

On 1st July 2013, the new regulation (UE) N° 305/2011 of the European Parliament and the European Council of 9 March 2011 entered into force. There, the harmonized conditions for the marketing of construction products are set out and the Council's Directive 89/106/CEE is repealed. Such Regulation provides common technical basis to evaluate the performance of construction products and guarantees the availability of reliable information for professionals, public authorities and consumers, allowing them to compare products from different manufacturers and countries. Therefore, CE marking gives an added value, in other words, manufacturers and distributors can market their products in any EU country ensuring that the performances of their products are those declared and they are supported by the document, standard or specification suitable in each case.

CE marking: compulsory or optional?

The compliance with the existing legislation is made compulsory by the company. However, the large number of existing laws for the different markets causes that in some cases the company may not be aware of all the responsibilities and may incur in non-compliance with the laws. This fact may have relevant implications, from penalties to ceasing operation of business extreme cases (Figure 1).

CE marking is compulsory in order to guarantee the performances of the products covered by the harmonized standards, bearing in mind the provisions on the intended use. In the Official Journal of the European Union you can consult their existence for a certain product. In cases where harmonized standards coexist with standards to what they replace and are still into force, CE marking is optional until the end of such coexistence.

In cases where there is no harmonized standard, it is possible to perform an optional CE marking. For that purpose, the first step is to check the existence of European Assessment Documents (EAD). If so, this involves that it is possible to develop a European Technical Assessment (ETA), previously named European Technical Approval in the repealed Directive 89/106/CEE, although with different definition and content. ETA is the documented assessment of a construction product for the manufacturer's intended use. Such assessment is performed by determining the performance of the essential characteristics that are important for the intended use, according to the European Assessment Document concerned, on the basis of the manufacturer's specifications, ITEC from the Regulation on.

The list of European assessment documents can be found on the European Commission website and in the information system NANDO (database of notified bodies). There is a specific webpage including the list of European Assessment Documents.

The document's content, including its application field, can also be found in the publications area of the EOTA website. If the product belongs to the application field of some of these documents, you can request to a technical assessment body (TAB) from the official registry of TABs to assess the product for CE marking purposes.

If the product and its intended use are not covered by any European assessment document, you can request to a technical assessment body to elaborate one for the product. This process requires more time than if there is already a European assessment document for the product.

In order to check the application field of the standards, it can be used the search tool in the website of CEN, the European Committee for Standardization. Products operating in the application field of a standard must have the CE mark according to the

dates shown in the chart. If the space for “reference of the superseded standards” is not blank, the CE marking of the products covered by this standard keeps being compulsory.

During the coexistence period, it is possible to choose the version to be used, either the withdrawn or the new, but once the coexistence period is over, it can only be applied to the revised version. This allows adapting, normally in one year, to the possible changes in the product assessment or in the declaration of performance.

The information for CE marking can be found in the standard's Annex ZA

In some cases, CE marking is not compulsory, although the product and intended use operate in the application field of some harmonized standard. These exemptions are applied to products manufactured individually or tailor-made for a particular use, or

those produced by means of traditional processes ensuring the conservation of officially protected tasks (cultural heritage, historical buildings, etc.).

In order to benefit from some of these exemptions, it is essential to make sure that it can be applied to the product, since otherwise there may have problems with the market surveillance authorities.

Systems of Assessment and Verification of Constancy of Performance (SAVCP systems)

Once defined the type of CE marking, the different assessment and verification of constancy of performance systems (SAVCP systems) define the main tasks to be performed. These are divided in obligations of the manufacturer and tasks to be performed by a notified body.

SAVCP systems	Manufacturer	Notified body
1+	- Factory production monitoring - Additional testing	- Performance assessment -Initial inspection (factory, product) -Ongoing surveillance, assessment and monitoring of the factory production monitoring -Audit-testing of samples taken by the body
1	- Factory production monitoring - Additional testing	- Performance assessment - Initial inspection (factory, product) - Ongoing surveillance, assessment and monitoring of the factory production monitoring
2+	- Factory production monitoring - Additional testing - Performance assessment	- Initial inspection (factory, product) - Ongoing surveillance, assessment and monitoring of the factory production monitoring
3	- Factory production monitoring	- Performance assessment
4	- Factory production monitoring - Performance assessment	-



FIGURE 1
CE Mark.

As can be seen, the role of notified bodies is essential over the whole process of certification: The notified bodies are entities that ensure the impartiality, the privacy and the independence, and also have the required expertise to certify the compliance of a product according to the agreed standards. Its impartiality with the competition and its responsibility are needed to carry out the certification of conformity according to the procedural and management rules established. In Spain, notified bodies must be accredited by ENAC, the National Accreditation Body.

As a result of the assessment process performed according to the applicable SAVCP, the manufacturer can fix the CE marking in the labels, packaging or delivery note of the product, thus guaranteeing that the tasks established by the Regulation and harmonized standards have been performed.

Moreover, the manufacturer must elaborate a declaration of performance as defined in the Regulation and including the following information, among others:

- Unique identification code of the product-type
- Use or uses intended

- Manufacturer
- Representative authorized
- SAVCP system or systems
- Harmonized standard/European Assessment Document
- Declared performances
- Suitable technical documentation and specific technical documentation

Therefore, CE marking is not given by the Administration or Notified Bodies. CE marking is put, under its responsibility, the manufacturer itself when performing tasks involving the EVCP system assigned to the product.

When a manufacturer puts the CE mark, it is guaranteeing that the performances of a marketed product are indeed those declared and they were defined by applying the right European technical specification.

From the date of entry into force of CE marking for a particular product, it is assumed that all the manufacturers of this product are obliged to have and exhibit the CE mark.

Main construction products from the plastics sector requiring CE marking

There is a broad variety of products used in construction that require CE marking within the plastics sector among others:

- Small wastewater treatment systems (many of them of GFRP)
- Bathroom fittings: shower trays, washbasins, whirlpool baths, sinks (most of them Solid Surface)
- Tanks for storing fuels
- Plastics sheets for waterproofing

The CE marking of these products is compulsory and is subject to different standards in each case, as well as different verification levels of constancy of performances. The fact of having a quality mark does not exempt nor replace the obligation of having the CE mark, although this is an essential requirement for having the mark. In AIMPLAS, the Plastics Technology Centre, the verification of performances of all the products mentioned is performed, both of system 4 (some sheets, bathroom fittings, shower trays) and system 3 (treatment plants and tanks for storing fuel). In this regard, AIMPLAS has the accreditation as Control Body for the evaluation of conformity of products with system 3, being the only Notified Body accredited by ENAC for this purpose at national level, although it can conduct its activities in these competences at international level for products manufactured in other countries that want to certify its product.

Solid surface composite materials

Solid Surface is a widely used material both for outdoor installations in enclosures and indoors in coatings for surfaces, washbasins and shower trays. It is obtained mainly from resins and mineral fillers by combining physical properties, such as durability, resistance, atocixity and easy-repairable, together with aesthetic properties, such as unlimited shapes, colours and textures.

According to the harmonized standard UNE EN 14527:2006 +A1 (September 2010), the compulsory tests for CE marking are:

Slipping resistance (R_a)	Class
$R_a \leq 15$	0
$15 < R_a \leq 35$	1
$35 < R_a \leq 45$	2
$R_a > 45$	3

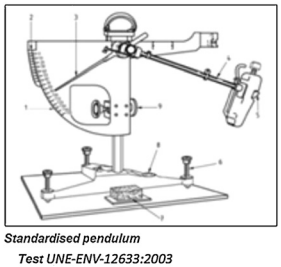


FIGURE 2
Standardized pendulum.

Cleanability

This test includes appearance of the surface. When a shower tray is inspected under a strong light obliquely projected, the surfaces intended to be in contact with water must have a smooth appearance, be non-absorbent and be free of inaccessible angles and corners that may block their cleanability. Surfaces with cracks, burrs or chips, microcracks or similar defects are not considered flat surfaces.

Evacuation of water

Shower trays must have at least one drain hole. The dimensions of this drain hole must meet the requirements of the Standard EN 251. Other dimensions are admissible if the manufacturer provides or recommends a suitable drain device. Water must be evacuated from the shower tray, except water retained due to surface tension.

Durability

Shower trays must be easily cleanable during their shelf life when a normal cleaning and maintenance is performed. Nevertheless, and due to the instruction at national level (Spain) and the Technical Building Code, in addition to these tests, slipperiness tests are also demanded (UNE ENV 112633:2003). In this test, by means of a pendulum a degree of slipperiness is obtained for floors and construction systems where slipperiness may affect people and the substrate.

In order to obtain the slip resistance, it must be tested by the pendulum test (standard UNE-ENV 12633:2003), as described in Annex A of the mentioned standard. This test consists of the energy loss of a normalized pendulum with a piece of rubber that, when dropping it from a horizontal position, grazes the surface to be tested with a determined pressure and in a previously defined trajectory. The energy loss is measured depending on the pendulum's swing angle on a set of dimensionless values (see Figure 2). The smallest values represent more slip-resistant floors or coatings.

Polyester-vinylester-glass fibre composite materials

Pre-manufactured tanks and treatment plants used to build houses and residential houses are made mostly of orthophthalic and isophthalic polyester or vinylester resins. For the reinforcement, glass fibre is used and all together forms the final composite, to be used in the following applications.

The standards associated to these products are UNE EN 12566-1 on "Small wastewater treatment systems for up to 50 pt. Part 1:

prefabricated septic tanks.” And UNE EN 12566-3 on “Small wastewater treatment systems for up to 50 PT – Part 3: Packaged and/or site assembled domestic wastewater treatment plants”.

AIMPLAS, as a notified body, is able to perform Structural Analysis tests (indirect method) and Tightness tests, common for both parts, as well as Hydraulic Efficiency and Capacity tests, belonging to part 1.

These tests, among others, give to the manufacturer, after inspection carried out by the Control Body (CB), the power of labelling its products with the CE mark.

CE marking is a standard that builds trust in the whole value chain of the construction market in Europe, what also generates new opportunities for companies and simplifies their procedures. Therefore, it is important to become aware of what it involves and the benefits for the market.

For any technical query related to these regulations, AIMPLAS has a wide consulting experience in this field.

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Longer fibers, increased strength

Manuel Wöhrle¹

When it comes to the cost-effective production of high-strength lightweight parts in large volumes, the length of the structural reinforcing fibers is of key importance. The rule of thumb here is: the longer the fibers incorporated in the plastics, the greater the resilience of the final products. The fiber length and content cannot be influenced in the case of ready-to-use fiber-filled granulate mixes. Things are different with innovative fiber direct compounding (FDC). Here, a side feeder can be used to incorporate fiber strands of variable length in the liquid plastic melt. This allows the mechanical properties of the parts to be improved. Moreover, it also offers significant cost advantages in comparison with fiber-reinforced standard granulate.

The use of fiber-filled plastics in lightweight construction is just one of several alternatives when optimum component properties are to be achieved and when every gram of weight counts. The focus here is on reducing weight without compromising on load-bearing capacity, rigidity or other design functions. Lightweight construction can relate both to the structure of an individual part and to a complete unit. Thus, for example, the use of honeycomb structures as they occur in nature has been a familiar feature in aircraft construction and in the automotive industry for many years. The trend toward electric mobility has caused this topic to gain considerable attention. Lighter batteries with greater efficiency and an increased range can only be achieved through consistent lightweight construction.

Fiber direct compounding (FDC)

If one considers the high demands placed on fiber-reinforced parts in automotive construction, for example, then it becomes clear that the individual adjustment of plastics and fiber lengths to the specific component properties is desirable. The technical solution for the processing of different fiber lengths that Arburg provides in the context of innovative fiber direct compounding (FDC) comprises a servo-electric side feeder with integrated cutting device, an adapted cylinder and a special screw geometry. The continuous fibers from inexpensive glass fiber rovings are cut into lengths before being added directly into the liquid melt

(Fig. 1). Fibers up to 50 mm in length can be cut in theory, however a maximum length of 33.6 mm has proven itself in practice.

Advantages of glass-fiber reinforced plastics

The most important advantage in using fiber-reinforced plastics is their great mechanical load-bearing capacity, which is not temperature-dependent. However, a noticeable effect on strength and toughness is only achieved with fibers exceeding a length of 2 mm. Distortion, creep and energy absorption are similar to those of metals, however with the benefits of thermoplastics. While conventional granulate mixes have fiber lengths between 0.3 and a maximum of 6 mm, the side feeder from Arburg enables fiber lengths of between 15 and 50 mm to be incorporated in the plastic melt. In addition to the fiber length, the fiber content and material combination (and therefore the part properties) can be individually influenced.

Greater part strength

In essence, the principle of the side feeder on the injection unit is very simple. The fibers are fed directly from a roving, cut to the required length by means of a cutter and added to the liquid melt. The screw of the injection unit has two sections. Firstly the plastic granulate is melted, then the cut fibers are fed to the front of the injection units and homogenized with the plastic through the movement of the screw.

A demonstration part illustrates the proportion of longer fibers that can be incorporated through FDC: when a conven-

¹ Senior Sales Manager Lightweight at Arburg.

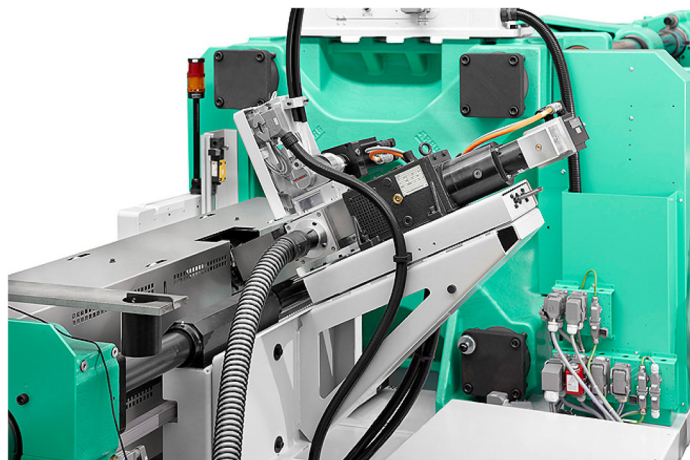


FIG. 1

During fiber direct compounding (FDC), the fibers are fed directly into the liquid melt by means of a side feeder on the injection unit.

tional long-fiber granulate is used, around 30 percent of the fibers are longer than 2 mm. With FDC and 16 mm fibers this percentage increases to around 50 percent.

Long fibers bring clear advantages

Fiber direct compounding offers clear advantages in comparison with long-fiber granulates: There is far less damage to the fibers during melt preparation, the strength of the components increases significantly and their properties can be influenced in a more targeted way through the individual adjustment of fiber length, fiber content and material combinations. Finally, FDC also offers immense cost benefits when the much less expensive base materials are used separately. During long fiber direct injection molding, long-fiber rovings and a bonding agent are required in addition to a standard commercial PP LGF 30 (Fig. 2). The cost benefit in series production is significant.

Feeding and cutting integrated in control unit

The FDC process can be fully integrated in the Selogica control unit with dedicated symbols. The symbols can be flexibly placed



FIG. 2

Cost-effective and flexible: The fibers are supplied as rovings and are cut to the correct length during fiber direct compounding process.

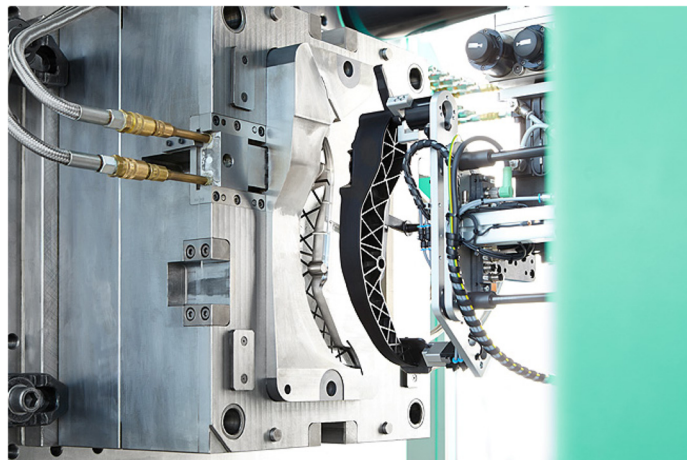


FIG. 3

Fiber direct compounding process can be used to produce a pedal and other reinforced lightweight parts for the automotive industry, for example.

at different points in the cycle sequence. A plausibility check is used to establish whether the sub-sequences are integrated in a rational way. This process is thus also incorporated in quality monitoring of the machine control system.

The flexibility of the process is also evident in daily use. Thus, for example, it is possible to use a wide variety of materials because many commonly used plastics can be reinforced with fibers in the manner described above. The enclosed structure of the side feeder enables injection molding by means of the thermoplastic cylinder modules of various Allrounder injection molding machines and rapid changeovers. The basic investment also remains modest when the system is used on standard injection molding machines with a clamping force of 275 tons or more. It is also possible to automate FDC. For example, a robotic system can be used to insert additional organic sheets into the mold, significantly enhancing the load-bearing capacity of the lightweight parts.

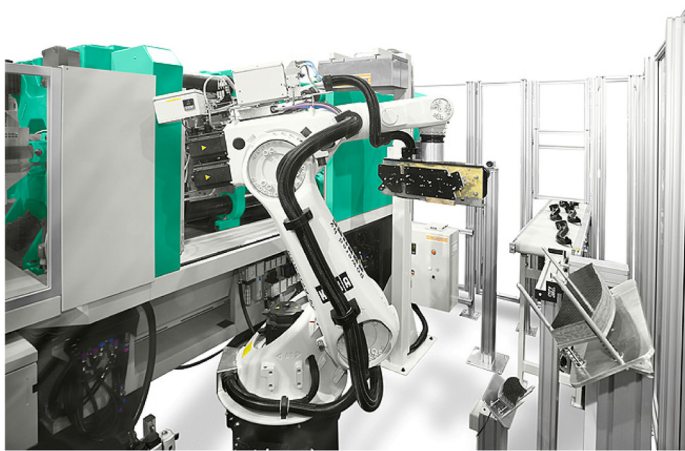
Combination of FDC with composite sheets

The continuous fibers, whether in woven or non-woven form, enhance the mechanical characteristics, such as strength and rigidity. The benefits of the multi-material design are exploited through the combination of the FDC process with thermoplastic composite sheets: the thermoplastic composite sheets provide extra strength. Highly resilient composite parts are produced that can replace metal in some cases.

An example for such a high-strength, lightweight composite component used in the automotive industry is a pedal for the automotive industry (Fig. 3). In order to increase the rigidity of the component, two additional organic sheet sections of different thicknesses are inserted into a single-cavity mold and further functional and reinforcing elements are subsequently molded on.

Fast and efficient: the process sequence

Firstly the organic sheets are gently heated by means of a heating plate in the gripper of the central six-axis robotic system before being brought to forming temperature via an infrared radiator. The organic sheets of different thicknesses can be brought to a

**FIG. 4**

The FDC process can be combined with organic sheets in order to increase the rigidity of the part. The process is performed using a six-axis robotic system.

uniform processing temperature by tilting the gripper. The forming process and subsequent overmolding then both take place in a special mold (Fig. 4).

The entire process has been tailored to high-volume production and therefore features an optimized use of time, including the various monitoring and quality assurance steps. Overall quality assurance and the temperature monitoring for the heated organic sheets take place inline by means of an infrared camera and a flexural test of the finished parts. The relevant quality parameters can be visualized graphically by means of the Selogica control system.

Highest part quality

When mold technology and the production process are perfectly matched, this kind of complex high-volume production operates absolutely smoothly and reliably. In detail this means that there are no open fibers due to the continuous overmolding of organic sheets. Injection through the organic sheets, e.g. in order to add screw domes or fastening lugs, does not damage the fiber structure. The components can be reinforced at any chosen position using sections of different thicknesses. A firm bond is created through the positive compression of the sections in the mold.

The processing of organic sheets together with FDC process enables much better strength values to be achieved. If additional organic sheets are integrated when producing the pedal system, the failure threshold when a load is applied is raised by 117 percent. A comparison with metal parts indicates a significant weight benefit in favor of composite parts. When made from metal, the part with a length of 500 mm weighs 533 g, while the same part in composite material weighs only 202 g. The differences become even more pronounced in the production process: The tested, ready-to-use composite part is produced in just 50 seconds, while it takes several days to produce the same part in metal.

Summary

When it comes to the production of high-strength lightweight parts, FDC combines several benefits:

- The composite parts can be produced quickly, simply and cost-effectively in high volumes.
- The glass fibers can be cut to any length from the roving, so that they can be individually adjusted to the requirements of the relevant part.
- They can be added directly to the liquid melt via the side feeder and homogenized.
- Automation and process integration can be comprehensively implemented using the Selogica controller.

Process integration is also the keyword for the combination of FDC with organic sheets. Preparation, production and quality inspection can be fully integrated in an automated process sequence, making production twice as efficient. Firstly, the material costs are reduced, and secondly, the manufacturing times are significantly shorter than those for the production of a metal part. This is how a high level of efficiency is achieved in the production of high-performance lightweight parts on a daily basis.

FDC series application “cable drive housing”

Highly strong and resilient at reduced manufacturing costs and up to 30 percent lower weight in comparison to the expensive high-performance plastic PBT: Good reasons for ROS GmbH & Co. KG from Coburg, Germany, to turn to fiber direct compounding (FDC). The company uses this process to manufacture cable drive housings for power-window car doors from PP with 30 percent long glass fibers (Fig. 5). Expensive pre-compounded granulate mixtures can be dispensed with.

The quality requirements at ROS are high: in addition to dimensional stability, strength, in particular is required. 50 percent of the glass fibers (weighted) in the part must be longer than 1.0 mm. Moreover, the cable drive housings are subjected to durability tests and testing for grease and heat resistance before they can be installed in a variety of vehicle models by the OEMs. An Allrounder 630 S with a clamping force of 275 tons and an FDC unit has been in operation since the spring of 2016. In addition,

**FIG. 5**

Fiber direct compounding (FDC) ensures that long glass fibers are distributed homogeneously in the part – as the photo of an automotive housing before (right) and after incineration shows.

tion to an adapted cylinder, this comprises a special screw and a lateral feeder with integrated cutting device. Long glass fibers with a length of 11.2 mm are fed via this unit.

The results speak for themselves. The cable drive housings made from 30 percent fiberglass-reinforced PP, measuring around 200 × 100 mm and with a weight of 50 g, are similar in toughness, strength and rigidity to comparable parts made from PBT. Moreover, they are up to 30 percent lighter than the previous PBT housings – and the cycle time is also shorter.

A 4-cavity mold built at the in-house mold construction shop is used. Direct injection with a pneumatic needle-type shut-off system is implemented. A linear robotic system removes the finished parts and transfers them to a weighing cell. Here, the component weight is checked and documented as an additional quality criterion. Next, the good parts are automatically separated and set down into the transport packaging according to the cavity pattern. ROS intends to produce around 1.5 million fiber-reinforced parts a year on the FDC machine.

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14–16 November 2018

Seoul, Republic of Korea
JEC Asia 2018
Contact: Anne-Manuele Hebert, JEC
Tel.: +33 1 58 36 43 93
www.jeccomposites.com

21–22 November 2018

Marknesse, The Netherlands
International Symposium on Composites Manufacturing ISCM 2018
Contact: NLR-Netherlands Aerospace Centre
Tel.: +31 88 5113113
E-mail: info@nlr.nl
www.nlr.org

28–30 November 2018

New Orleans, LA, USA
International Workboat Show 2018

Contact: Diversified Exhibitions Australia
Tel.: +61 3 9261-4500
Fax: +61 3 9261-4545
Email: cdimmerling@divcom.com
www.workboatshow.com

4–6 December 2018

San Diego, CA, USA
Carbon Fiber 2018
Contact: CompositesWorld
Tel.: +1 858 552 1234
www.compositesworld.com

20–31 January 2019

Amsterdam, Netherlands
Composites in Construction
NetComposites Ltd
Tel.: +44 01246 266 246
E-mail: info@netcomposites.com
compositesin.construction

19–21 March 2019

Birmingham, UK
Aerospace Forum Birmingham 2019
Contact: advanced business events
Tel.: +33 01 41 86 41 60
Fax: +33 01 46 04 57 61
Email: ltheemstra@advbe.com
www.birmingham.engine-meetings.com

16–18 April 2019

Abu Dhabi, UAE
Global Space Congress 2019
Contact: Streamline Marketing
Tel.: +971 4 332 9029
Fax: +971 4 332 9648
Email: info@globalspacecongress.com
www.globalspacecongress.com

23–25 April 2019

Moscow, Russia
Composite-Expo 2019
Contact: Mir-Expo Exhibition Company
Yury Andropov's avenue, 22
Tel.: +7 499 618-05-65
Email: info@mirexpo.ru
www.composite-expo.com

11–13 June 2019

Shanghai, China
Aircraft Interiors Exhibition China 2019
Contact: Shanghai Golden Commercial Exhibition Co Ltd
Tel.: +86 21 5013 1760
Fax: +86 21 5013 1761
Email: info@goldenexpo.com.cn
www.aircraftinteriorsexpo.com.cn/fair/en

9–11 April 2019

Singapore, Singapore
SEA-ASIA 2019
Contact: Seatrade Communications Singapore Pte Ltd
Tel.: +65 6294 2280
Fax: +65 6294 2780
Email: jkhoo@seatrade-asia.com
www.sea-asia.com

29 April–2 May 2019

Chicago, IL, USA
AUVSI XPONENTIAL 2019
Contact: AUVSI, Association for Unmanned Vehicle Systems International
Tel.: +1 703 845 9671
Fax: +1 703 845 9679
Email: info@auvsi.org
www.xponential.org