



shape

Gurit

The Gurit Magazine N° 14
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Visual Carbon applications with Gurit resins and prepregs
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Cruising faster than some will ever race
Rethinking helicopters
Walking across Auckland Harbour

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Design Eclat AG, Erlenbach

Dear Reader

In 2013, Gurit has faced the most difficult year ever in its global wind energy business. The robust growth of our materials sales to marine and industrial customers, the relatively stable aerospace business and even the very strong surge of the Composite Systems and Engineering business could not compensate for the sharp sales drop in wind energy. The overall sales volume of CHF 281 million generated in 2013 was disappointing. But there is good news, too, at Gurit.

We can state that the strategic decisions made at the beginning of last year proved to be right. We are transforming Gurit into a Group that combines a large global Composite Materials Business and a smaller, yet rapidly growing Composite Systems and Engineering unit. We are leveraging our global sales capacity as Maricell's new exclusive distributor for PVC materials outside of China. What is more, after having doubled the capacities in our UK automotive plant in 2013, we are soon opening a new production site in Hungary which will serve our Systems and Engineering unit as its continental European hub. While it's too early to report more extensively on this now, SHAPE will certainly pay a visit to Hungary for our next edition.

This current edition of SHAPE highlights spectacular projects from both our business units. Several projects also show how the two units interlink and support each other: Gurit was again involved in high profile marine and civil engineering projects, both as engineering partner and materials supplier.

Understanding the most pressing needs of our existing and potential customers drives innovation. In 2013, we have again launched interesting new products – such as the new cosmertic carbon fibre prepregs which we developed explicitly for the automotive industry – one of the most promising and fastest growing markets for Gurit.

Please join us again discovering how Gurit is committed to deliver the future of composite solutions.

Yours sincerely
Rudolf Hadorn CEO

A handwritten signature in black ink, appearing to read 'Rud. Hadorn', with a stylized flourish extending from the bottom right.

Mirroring current developments, anticipating future trends



A white motor yacht, the Majesty 155, is shown from a side-on perspective, moving across a deep blue sea. The yacht has a sleek, modern design with a white hull and a dark upper section. It features several portholes and a small cabin structure. The sea is a vibrant blue with gentle waves, and the sky is a clear, light blue with a few wispy clouds on the horizon. The yacht is leaving a white wake behind it.

There are only few new boat projects which mirror recent developments and future trends in motor yachts as illustratively as the luxurious Majesty 155. Erwin Bamps, COO of Gulf Craft, explains how Gulf Craft's largest build to date provides answers to these tendencies.

«We all know that the last couple of years were tough ones for the boat building industry. But change also creates opportunities. While there was a noticeable consolidation amongst yacht builders, the market continued to develop. It has become more exclusive; buyers today seek larger boats, and they look at ways to express their individuality more. In addition, a lot of new yachting infrastructure is being built in unspoiled, often warmer sea areas of the world where yachting is a still quite new phenomenon but where a fascinating outdoor water world is waiting to be discovered», Erwin Bamps summarises some of the major trends Gulf Craft have identified as key drivers of tomorrow's superyacht market.

Located in the United Arab Emirates, Gulf Craft has prime insight into key developments of the Middle Eastern market, one of the most dynamic yachting markets worldwide. They are very confident about the market potential of this region as more affluent people are finding their way to the waters which become

more attractive as the infrastructure for superyacht berthing and luxurious marinas progresses rapidly.

The market consolidation has created a new league of global yacht builders who have the capability to build composite superyachts in the realm of 45 metres and more. «At Gulf Craft we are now progressing into this market segment. Following our Majesty 125 and Majesty 135 models, we have now begun work on Majesty 155, the largest displacement motoryacht for our company so far.»

Larger vessels ...

What seems to be a logical and gradual move is qualified as a strategic leap by Bamps: «The new boat certainly implies more complexity in engineering. At the same time it offers us the opportunity to demonstrate our capabilities, new design solutions and innovative, very individual superyacht concepts that incorporate many new features as direct answers to the market trends we have identified.»

Gulf Craft has a large in-house engineering and drawing office but they have always been open for valuable external input. «Gurit has a long-standing relationship as a material supplier with Gulf Craft. But as our products are typically engineered materials or end up in engineered structures, on-the-job consulting goes hand-in-hand with our offering», says Rudy Jurg, Gurit Sales Manager Middle East & Africa. This is why Rudy likes to visit key customers generally together with a colleague from the engineering or the technical department to provide practical and engineering support on site. Working closely together with Gurit on various jobs and projects has helped Gulf Craft to gradually grow the size of its vessels. «Today, they are ranked as one of the largest composite superyacht and motor yacht builders in the world. We have no doubt that larger vessels will follow on request from their loyal customer base», Rudy commented. For Majesty 155, support from Gurit's engineering department even went a few steps further: «We developed the full structural arrangement based on the client's brief which defined the locations of interior elements such as cabins, guest spaces and crew spaces along with the principal machinery such as engines, propellers and stabilisers. In a next step, we have then provided detailed construction drawings for the key structural components including the hull shell, the hull girders and bulkheads, the decks and superstructure», Steve Shaw, Senior Design Engineer at Gurit added.

... for warmer waters ...

Along with the structural design work, Gurit also suggested a suitable materials package: «To keep the production process as familiar as possible, we started off with Gulf Craft's standard palette of reinforcing materials – materials they carry in stock or can readily source. The resin choice was based on Gulf Craft's current experience and preference», Steve explains.

The construction of the Majesty 155 boats is in hand laid polyester e-glass sandwich structure with Gurit® Corecell™ M-Foam as core. Gurit® Corecell™ M-Foam was selected for several reasons: It obviously meets all the required mechanical properties, especially in terms of toughness and impact resistance. What is more, it allows for single-sheet and even comparatively narrower thicknesses to be used for



True beach-club atmosphere right on water-level draws people outdoors.



The upper aft seating offers the ideal setting for dinner.



When moored, the balcony extends the owner's stateroom to a luxurious apartment on the water.



shell components and bulkheads and it is thermally more stable which is an important consideration for the topsides on large motoryachts which often operate in the tropics. «This is a true differentiator for Gurit® Corecell™. Gurit® Corecell™ M has high temperature resistance and very good insulation properties. Also, Gurit® Corecell™ M does not create any out-gassing issues, an important safety and comfort factor which unfortunately is a rather common problem for other core materials when boats operate in higher temperature waters», Rudy explains. Erwin Bamps adds: «In addition, Gurit® Corecell™ is an easy to handle material which can easily be cut into the correct size and forms. This greatly facilitates our building process. From a marketing point of view, Gurit® Corecell's many type approvals including Lloyds, RINA, GL, DNV, ABS and BV are another argument for the material. We build our boats under different type approvals depending on the future owner's choice or the requirements of the country where the boat is exported to. The extensive list of approvals of Gurit® Corecell™ gives Gulf Craft additional flexibility.»

... and exclusive customer classes

The design of the vessel celebrates the «living on water» concept with exterior and interior coming together in a barrier-free luxurious apartment and beach club atmosphere. Oversized windows deliver tremendous panoramic views over the water from within the air-conditioned interior. Spacious balconies directly accessible from the master cabin or the saloon as well as the inviting water-level beach club on the aft deck draw people outdoors. «The yachts are clearly overspecified to deal with the extremes of weather and operational conditions. With a view to the emerging yachting destinations, this includes superior cooling capacities to cope with harsh tropical sun. Technical maintenance access is kept easy and straight forward throughout the vessel, especially of concern in case of ocean crossings, longer trips or when the boat operates in areas where adequate service facilities are at a considerable distance. This adds peace of mind to the luxurious, sophisticated comfort of our boats,» says Bamps.

Gurit distributes PVC structural foams from Maricell

Gurit and Maricell, an Italian producer of closed cell PVC, signed a mid-term distribution agreement which has come into effect as of January 1, 2014. According to this agreement, Gurit will – in addition to producing and distributing its existing range of core materials including Gurit® Corecell™, Gurit® PVCcell, Gurit® G-Pet and Gurit® Balsaflex – exclusively distribute all Maricell PVC structural foams globally with the exception of the markets in Mainland China, Hong Kong and Macão, where Sino Composites is the existing

exclusive distributor of Maricell PVC materials. Gurit and Sino Composites will both distribute Maricell PVC in Taiwan. Maricell will continue to sell smaller volumes of PVC to its existing Italian customer base and also continue to sell its LYcell product range.

For Gurit, the agreement significantly enhances the availability of high quality PVC as a traded product and provides for Maricell access to Gurit's global distribution network in all relevant target markets.

Welcoming distributors as ambassadors

In October 2013, Gurit held a two-day international seminar in Portsmouth and Newport for its European, Middle Eastern, and African distributor network. «The key objective was to share Gurit's global brand and marketing strategy with our distributors», said Stefan Gautschi, General Manager Gurit Composite Materials. «The distributors of Gurit are key promoters of our products in their respective markets and target industries and act as Gurit ambassadors».

«At the same time, we introduced our distributors to the many recent product innovations in hands-on

workshops and presentations and familiarised them with the full scope of Gurit's composite materials range», added Andy Pointon. «As our distributors are a decisive element in the implementation of our global sales strategy, we wanted to strengthen our partnership and show them first-hand what the new generation of Gurit materials is capable of». Some distributors who have been well-acquainted with certain Gurit product ranges discovered additional material categories which could be true problem solvers for some of their customers.



Product Stewardship moves toward GHS

«Product stewardship encompasses environmental, health, and safety protection over the full lifespan of a product. It includes the communication of safety information and hazards to customers, compliance with health and safety legislation and global regulations concerning the import /export and use of chemical-based products», explains Amy Moram, Global Product Stewardship Coordinator at Gurit.



Safety datasheet management

A product may present a hazard. «Safety Data Sheets (SDS) will identify such hazards and will also mention specific information such as composition of ingredients, first-aid and fire-fighting measures, ex-

posure controls, personnel protection, physical and chemical properties, toxicological and ecological data, stability and reactivity», added Christian Moreau, Environmental & Industrial Hygiene Coordinator at Gurit (Americas). SDS are the most common way to communicate chemical hazards, properties and transportation guidelines from the raw material producer to the end user of final products, and all those in between. «The seamless SDS management throughout the whole supply chain is crucial. We must ensure information received from suppliers is accurate and of good quality in order to pass it on to our customers.»

Moving towards a globally harmonised system

Regulatory compliance has become more complex in recent years with the advent of REACH (Registration, Evaluation and Authorisation of Chemicals) in Europe and other regional or national systems such as TSCA in the USA, China «Reach» and Japan CSCL (chemical substances control law). «Our Product

Development group keeps all these aspects in mind when developing new solutions for our global customer base», explains Amy. «They need to understand our materials and their end uses, they need to be familiar with the specific requirements of our end markets and they need to recognise where and how our suppliers fit in and what they have to comply with.»

Regulatory compliance is a dynamic process with new legislation being implemented and changes continually being made to existing systems. Gurit is proactively looking for such changes to ensure customers have the most accurate information and that the supply chain is maintained globally. As the SDS format and content varies among countries, Gurit is moving towards the United Nations' Globally Harmonised System of Classification and Labeling of Chemicals (GHS). With GHS for mixtures coming into force in 2015 in the EU, Gurit is currently preparing its processes and ensuring customers are suitably educated and supported during this transition.

REACH

- Developed by EU. Regulation (EC)1907/2006
- Registration, Evaluation and Authorisation of Chemicals
- Came into force on 1st June 2007
- Deadline for registration of chemicals manufactured <1t/yr 1st June 2018

GHS

- Created by United Nations
- Globally Harmonised System of Classification and Labelling
- Implementation dates are country dependant
- EU implementation: 2010 for Substances, May 2015 for Mixtures
- USA-OSHA implementation date: June 2015

Walking across Auckland Harbour

Auckland Harbour Bridge (AHB) has not provided any walking or cycling access since it was built in 1959. The two box girders «clip-on» lanes added in 1969 did not change that as they merely provided additional road traffic capacity. With SkyPath, the famous Auckland harbour crossing will – finally! – provide a shared walking and cycling path on the city side of the bridge.

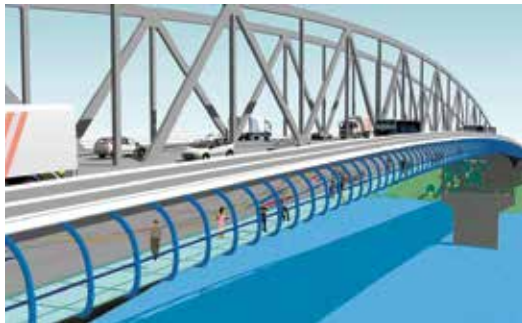
SkyPath is the talk of the town. It is being developed and championed by the Auckland Harbour Bridge Pathway Trust, a charitable trust whose aim is to have a world class walking and cycling facility on the AHB. In order to implement SkyPath as a community facility, it is proposed to provide funding by charging fees for users, including tourists, recreational users and commuters. Optimised cost, low maintenance and longevity are obviously very important to a project like this.

Seize the benefits of composites

The New Zealand Herald applauds that SkyPath will be built out of «space-age materials». Well, if not tried and tested in outer space, composites certainly have proved their supremacy over traditional building materials in marine and maritime conditions. The Auckland Harbour Bridge Pathway Trust explains: «SkyPath is capitalising on New Zealand's marine expertise by proposing the use of composite materials and manufacturing technology developed for the America's Cup.» SkyPath will be constructed by Auckland yacht builders who built the Team NZ and Oracle America's Cup catamarans. Project Director Bevan Woodward says: «Whilst we've had to go through a significant design update and testing programme, we have now achieved a composite solution for a similar price to steel and aluminium construction. This means SkyPath will be stronger and lighter, will be easier to implement and have much lower maintenance costs with a service life of at least 50 years.»

Over the past decades, the two box girder lanes of the Auckland Harbour Bridge have been the object of significant structural issues, strengthening work and on-going maintenance. As those in the marine industry would be well aware, when a stiffness critical structure requires reduced weight and low maintenance, composite structures have a distinct advantage. Gurit has lent its expertise to provide the Auckland Harbour Bridge Trust, Airey Consultants and Core Builders Composites with a practical solution utilising all the benefits of composite construction.





Core Builders Composites project manager Tim Smyth says: «The use of composite materials for buildings and bridges has been proven overseas. We propose to work with a number of Auckland composite manufacturers in a similar programme as the successful production of the 14 America's Cup AC45 catamarans. We would deliver SkyPath in 14 metre long, 4 metre wide sections ready for nightly installation onto the city side of the Harbour Bridge.» According to Gurit's and Core Builders' proposal, SkyPath requires over 4000m² of sandwich panel decking, some 250 10-metre long E-Glass and carbon reinforced ribs.

Concept design and design standards

Gurit has been involved working closely with the team from an early stage developing a composite solution from a newly developed geometry and the loading constraints of the existing steel bridge structure as outlined and studied by Airey Engineering. The conceptual geometry including the main deck/pathway and structural beams and ribs were modelled and a finite element analysis was carried out on the modules in the central navigation span which were deemed to be the most critical due to the lack of available depth. The design of the FRP structure was carried out in accordance with a coherent Limit State methodology with the actions and load combinations taken from a relevant design codes. This design approach has been used by Gurit for the design of a wide range of civil and architectural FRP structures installed around the world using Euro Code or International Building Code to define actions and load combinations. Global laminate specification was found to be driven by deflection criteria at the Serviceability Limit State. Local reinforcement and additional structure in

way of the connections to the steel bridge structure is driven by static strength criteria at ULS. Fire performance was considered and the structural material choices meet NFPA Class B.

Materials

This preliminary analysis has led to a conceptual laminate based upon a Gurit® GPET 100 FR foam core with a quadraxial E-glass skins for the pathway and beams. The FEA was beneficial in determining the most efficient use of carbon uni-directionals and E-glass uni-directionals in the rib and frame specifications.

Weight and Cost Saving

A weight and costing study was carried out carefully due to the weight critical requirements of the existing bridge allowing for a comparison and review of the loading to the original metal concept that had been proposed previously. Further development in the full design stage will be needed to extensively review all sections and details but at this concept stage 250 tonnes saving is predicted.

A showcase for the New Zealand composite industry

For a project of this scale and given the tight timeline that aims at completing the construction of SkyPath by the end of 2015, the cooperation of the wider New Zealand composite industry will be required. NZ Marine Industry Association's Peter Busfield says «We believe SkyPath will be an exciting showcase for the NZ marine and composites industries. It will be a high profile demonstration of our expertise that will enable us to talk to many other sectors about utilising our services, and not just in NZ but internationally.»



Cruising
faster
than some
will ever
race



As a candidate for Boat of the Year, the stunning sailing yacht Premier 45 attracts the attention of cruising and racing enthusiasts alike. Naval architects Botin and Carkeek and interior designer Snøhetta created a perfect synergy of performance and comfort. Premier Composite Technologies of Dubai relies on a broad selection of Gurit materials to manufacture this boat, including vacuum bag infused carbon, E-glass, Gurit® Corecell™ and Gurit epoxy resin.

Depending on the focus of the sailor approaching a Premier 45, different aspects first catch the eye: Clearly distinguishable features such as the broad and open aft of a fast boat, the carbon mast and boom, the fully retractable carbon bowsprit, the E-glass wheels or the uncluttered shipshape deck's layout featuring full Harken gear fascinate any racing sailor. Exclusive design elements like the countersunk position lights, the sleek look of the cabin which seems to float on deck, the integrated grab rails, full roof skylights and flush hatches, or the transom swimming platform all promise ultimate cruising and relaxation comfort, even before one has discovered the inviting LED-lit, high-tech,



yet cosy, interior. The Premier 45 has surprises in store for everyone. Have you ever seen a clear carbon toilet on a sailing boat before?

Max Waimer, Technical Director of Premier Composite Technologies LLC of Dubai (PCT), has good reason to be proud of this next-generation performance cruiser. A generous up and downwind sail area and a low displacement and limited wetted surface area get the boat quickly moving in lighter wind. Whoever sails a Premier 45 will probably use the engine far less than on any comparable boat. And he or she will likely spend more hours on the water than before. The boat is easy to sail, even with few hands on deck. With the option of a lifting keel, quite a unique feature on a luxurious performance cruiser of this class, the solid 2.8 metre draft can greatly be reduced to 1.8 metre to allow access to shallow anchorages or to visit the town quay of any quaint

holiday spot without compromising sailing performance in heavier conditions. The boat wants to go and discover without limits.

The hull design has been developed to excel both up and downwind and maintain stable handling in waves when further offshore. «The boat is built for speed», Max says. «Performance was top of our list and even defined many aspects of our building process. With a lightweight, E-glass/carbon hull, full carbon deck and composite interior structure, Premier 45 is built in an epoxy resin vacuum bag process using female moulds that were created using 5-axis CNC milling». What could be built in lightweight carbon obviously was. Where high-tech CNC accuracy could be achieved, it was. The result of this concept and high-end building process is a fully equipped



Catchy design elements all around, from the wheels to color-adjustable LED lighting on deck and in the cabin to the fully retractable carbon bowsprit and carbon toilets.





yacht of just 8.1 tonnes, 40 % of that as counterweight in the keel.

For the construction, PCT opted to build the boat in resin infusion technology using Gurit Prime™ 27, a low viscosity epoxy infusion resin. They also choose Gurit® Corecell™ M-Foam as sandwich material and flow medium and Ampreg 22 for epoxy wet lamination of smaller parts which were bonded in with Spabond 340LV epoxy adhesive. All products used are Germanischer Lloyd approved to reinforce the high quality of build and materials. The roomy interior that sleeps seven, features an interior design concept designed by Norwegian architect Snøhetta.



A striking feature is the almost full-circle window in the coach-roof, visibly translating the lightness of the boat into brightness inside. The Nordic style interior also includes an inviting Corian kitchen and smoked oak floorboards with countersunk, colour-adjustable LED lighting that easily adapts to any nautical needs when sailing round the clock or creates a soothing atmosphere for relaxation. The heads made of clear carbon are yet another proof that weight saving was a goal. The cabins are roomy and uncluttered. As one is likely to stay on board as long as possible, a holiday sailor might appreciate more easy-access stow-aways. But maybe tourist luggage just compromises the lightweight features. And the best souvenir to bring back from whatever length of stay on a Premier 45 is to know that you cruised faster than some will ever race!

History meets technical advancements

Marsden Cross commemorates the place that became New Zealand's first missionary settlement, where Reverend Samuel Marsden preached his first sermon on Christmas Day 1814. Plenty of celebrations are planned to mark the bicentennial anniversary this year, and Gurit has been involved in the creation of an impressive new landmark, the Interpretive Centre.



The Interpretive Centre is orientated directly towards the historic Cross where visitors can also walk down to. Its design is characterised by the contrasting curved rammed earth walls, symbolic of its grounding into tradition, with the thin triangulated composite roof, symbol of high technology, engineering and lightness. Gurit was brought in to help the project managers meet the budget while achieving the modern geometric design, and ensure the roof is structurally sound for years to come. After extensive engineering analysis, using a parametric model to combine shape and laminate optimisation, a final epoxy infused laminate of E-glass/Gurit® G-PET™ 90 was derived.

The architect, Pip Cheshire, wanted the engineering solution

to drive the final geometric shape, not only because it was part of his design intent, but also because it was the only way to produce a design that would be buildable within a fixed budget. In close conjunction with Pip and the builder, Core Builders Composites, the engineers evaluated a number of design options, including additional structure, additional posts, and geometrical modification, in order to evaluate the cost benefit of each, and thus find the optimum solution. In the end, the addition of posts along with geometrical modifications allowed for additional structure not to be used, and achieved the lowest cost. The geometrical modifications were devised thanks to the optimisation functionalities of the Altair Hyperworks software, which



allowed for varying the heights of the peaks of the structure, concurrently with varying the laminate. Definition of the material cost as a custom design variable within the software allowed for driving the optimisation towards minimising cost rather than the more usual objective of minimising weight. Finally an optimum was found between minimum material cost, and structural integrity, while realising the artistic intent.

One of the benefits of having chosen composite materials for building the roof is that Core Builders Composites was able to pre-assemble the roof in two large parts at their factory. These were then trucked to the construction site where they were joined into the full roof assembly, which was lifted as one piece onto the supporting posts, thus minimising installation time. The architect is thrilled with the results and has made very positive comments about Gurit's involvement in his numerous public presentations of the project.



Keeping the balance with Gurit® Corecell™

U-Boat Worx was founded in 2005 in the Netherlands with the intention to build something manoeuvrable, safe, comfortable and more economical than old-fashioned submersibles. The company certainly succeeded here. What is more, these fascinating subs rely on Gurit® Corecell™ material on their quests down to an amazing 1000 metres!

U-Boat Worx launched its first single-seat submersible, the C-Quester 1, in its first year of operation. Additional models soon followed and today U-Boat Worx offers a range of C-Questers and C-Explorers submersibles for up to 5 people. They are all certified by Germanischer Lloyd for depths ranging from 100 up to a staggering 1000 metres. The submersibles are built in small series: «This brings cost and lead-times down to very acceptable levels», says Erik Hasselman, Commercial Director of U-Boat Worx. The versatile C-Quester and C-Explorer submersibles stand out in terms of their reliability, spacious and luxurious interior, powerful air conditioning system, small size, low weight and short lead times. «They are operated from private yachts, in tourist ventures, for research missions and for private recreation», explains Erik. The subs are built out of a steel frame with an acrylic pressure hull. Gurit® Corecell™ plays a vital role, too, keeping them in balance underwater: Blocks of Gurit® Corecell™ S-Foam are used on some of the models to compensate the balance of the submarines when optional items like e.g. manipulator arms are added. Gurit® Corecell S-Foam features a very fine cell size which makes it very tough in terms of ductility and damage tolerance on the one side and very easy to machine into almost any kind of shape on the other. Most important, however, for this exceptional use «is its excellent weight-to-buoyancy ratio», Erik concluded.

Technical Aura

Visual Carbon – Show and tell, Part 1

No other material beats carbon fibre composites in terms of light weight, stiffness and durability. Carbon stands for performance, exclusivity, and class. In a growing range of applications, carbon fibre is therefore no longer a hidden structural feature but something designers, builders and product owners are proud to show.

The exclusive motor bike body kits manufactured by Vskcorrinaldi, Liverpool, are a great example for visual carbon fibre. The carbon weave style which shows through the ultra-clear resin matrix of the composite body panels gives motor bikes a completely new look. John Corrin of Vskcorrinaldi says: «We want to offer our clients a complete service from one-off prototypes, to production runs, with the emphasis on customer service and product quality. There is no better way to show how carefully our body parts are manufactured than to show the accurately placed, harmonious weave structure of the carbon fibre fabrics. At the same time, visual carbon creates an unparalleled exclusivity for the owners of those motor bikes.»

To impeccably show the carbon fabric, John relies on Gurit's Ampreg 21, an epoxy wet laminating system with non-pigmented resin and hardeners, and especially SP 115, a clear epoxy wet laminating system. «Especially developed for laminates with embedded graphics or attractive fibre weave styles which are exposed to heavy sunlight, SP 115 gives the

final structure a characteristic, transparent violet-blue glow», explains Martin Armstrong, Composite Technologist at Gurit (UK). This technical aura superbly blends in with motor bike body panels.

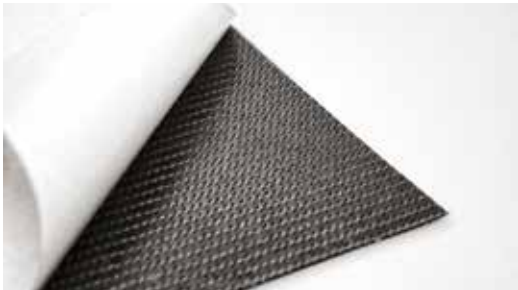
At Vskcorrinaldi the lamination experts lay dry carbon, aramid or hybrid material into mould tools and wets these out with the properly mixed epoxy resins. The mould is then covered with a plastic sheet and sealed around the edges. Now the air is sucked out, so that the outside air pressure pushes the yet to cure composite material against the tool surface. This pressure aids adhesion between reinforcement layers and squeezes excess epoxy from the reinforcement fabric. The epoxy then cures to a hard state over the next 1 to 14 hours. This process is ideally suited for small series of parts as it does not require extensive equipment and can be carried out at normal room temperatures. It produces light, stiff and strong parts with visual carbon fibre.



Cosmetic carbon for cars

Visual Carbon – Show and tell, Part 2

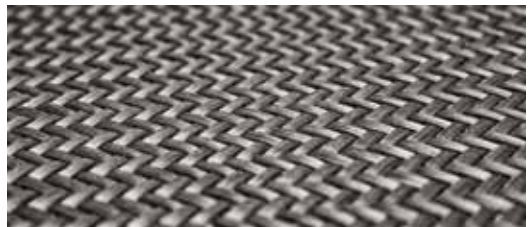
Carbon fibre is increasingly becoming a feature of newly launched cars, both as visual carbon parts and for structural applications. Gurit is targeting this emerging market with a newly launched package of prepregs. «Traditionally, composite materials were exclusive features of high-end supercars and luxury vehicles to lighten the weight or for visual appeal», says Damian Bannister, Head of Technology at Gurit. «CO₂ reduction and fuel efficiency targets are increasingly driving higher volume manufacturers to incorporate these smart materials into their next designs.» Gurit has thus developed a series of prepreg products supporting a variety of series manufacturing processes and specifically answering automotive product requirements.



SC 110 is a cosmetic grade carbon prepreg that utilises a high clarity, versatile, hot-melt epoxy resin formulation. The unique formulation ensures that no white-wash or spots are evident in the cured resin, reducing scrap rate by up to 20 %. It is ideal for manufacturing high visual quality components using autoclave, press and vacuum-only processing. It can be cured at temperatures as low as 80 °C, or it can be used for faster moulding of components at 120 °C. Even faster cures are achievable using press moulding technologies at temperatures up to 150 °C. This is achieved whilst maintaining a good out-life of up to 3 weeks at 21 °C. It is a toughened system, and offers excellent mechanical properties on a wide variety of reinforcing carbon fabrics and fibres.

SE 200 is a high strength toughened epoxy system for structural prepregs that has a flexible cure envelope ranging from 135 °C to 200 °C. SE 200 has been developed to enable rapid part manufacture through a number of composite processing methods. The minimum cure temperature is 135 °C from which SE 200 develops a Tg and mechanical properties associated with higher temperature curing systems. Higher temperature cures in excess of 180 °C will achieve the best dry and wet thermal performance. Using the appropriate press moulding technology it is possible to achieve a 210 °C Tg after a 15 minutes hot-in/hot-out cure at 195 °C, making SE 200 suitable for the economic production of automotive parts. SE 200 structural prepreg can be used in the making of parts such as structural lower tubs, bulkheads, front and rear scuttles, gearbox tunnels and other structural components.

PN 901 is a high-Tg cyanate prepreg resin for high temperature composite applications, as it combines the ease of processing and handling convenience of epoxy resins, high temperature stability of polyimides, and flame/fire resistance of phenolics. A 120 °C cure for 75 minutes combined with a post-cure, enables PN 901 to generate a Tg in excess of 300 °C, making PN 901 ideal for applications in composite structures, which are exposed to very high temperatures for short durations. The flame and smoke characteristics of PN 901 composites show that this resin possesses superior flame retardant properties and holds a wide range of Aerospace grade FST (Fire/Smoke/Toxicity) standards.



Balancing performance and luxury

TAG 60 regularly outpoints larger monohulls due to its carbon centerboards and its powerful sail plan. It reaches broader wind angles thanks to the slim hulls, sail plan and rotating mast, and sails downwind like a racing cat. Yet, TAG 60 features a superyacht level interior!

TAG Yachts selected carbon fibre fabrics with Gurit® Corecell™ structural foam and epoxy resins for the TAG 60. «Opting for Gurit's high performance materials, plus vacuum consolidating and post-curing the laminates, meant that we could achieve excellent structural properties and save weight,» says Doug Koch of TAG Yachts. «This has allowed us to fit out the yachts to a modern European style superyacht standard.» Gurit's Structural Engineering team was also engaged by New-Zealand based designer Greg Young from an early stage: «I have worked with Gurit for 20

years. They have a huge amount of composite design experience and the necessary skills and resources to help us meet our brief.» The signature Greg Young exterior styling, combined with the open plan living space, provided numerous engineering challenges on a boat that is capable of flying a hull.

FEA optimization

After completing the preliminary structural design, finite element analysis (FEA) was used to optimise the global loads of the structure. The vessel's bulkheads, hull and superstructure, forebeam and prod all work in unison without impacting on the interior. The mast bulkhead, often solid or near-solid on a cat, posed an interesting challenge: FEA was once again employed to refine the all-carbon bulkhead design, producing a structure that could safely support the massive mast compression loads generated by this design, while the passengers move through the opening in the mast bulkhead without any sense of the magnitude of loads being transmitted over their heads.

Ampreg 22 epoxy with a series of hardeners

Hull and deck are constructed of carbon fibre fabrics, wetted out with Gurit's Ampreg 22 epoxy laminating resin, either side of Gurit® Corecell™ M-Foam. «Ampreg 22 has worked extremely well for us,» says Young. «The range of hardeners allows us to adapt the system to suit the part being built.» Gurit® Corecell™ M-Foam is an ideal choice for designers and builders requiring a lightweight, yet stiff, structure. It acts as an I-beam, separating the carbon fibre skins of the laminate, maintaining the shear connection between them and creating a stiff, lightweight laminate.

Efficient structural design and specification is all very good on paper, but the builder has the task of ensuring the build process adheres to the plan. By keeping the entire production process in-house, from the laying of the first fibre in the mould to the final painting and upholstery fitting, TAG Yachts has complete control over the process and quality.



Rethinking helicopters

On November 28, 2013, the prototype of an entirely new helicopter concept saw its official roll-out in Switzerland. Announced to the market at the 2011 Heli-Expo in Orlando, Florida (USA), the SKYe SH09 immediately met with great interest. The prototype rolled out at Mollis Airport in Switzerland features Gurit prepreg.



SKYe is the world's first completely fresh helicopter concept in 35 years.

Martin Stucki, Chief Executive Officer of Marenco Swisshelicopter and designer of the helicopter, explains: «SKYe is the world's first completely new helicopter concept in 35 years. It's hard to believe that all other helicopters in this category and on the market today represent merely updated versions of former craft. At Marenco Swisshelicopter, we took a completely fresh look at what helicopters could and should be today». Rethinking the concept of helicopters led to unique features that make SKYe a very versatile craft. Rethinking also included

and required a novel approach to building materials. The SKYe SH09 is almost entirely built of composites. As a key prepreg supplier, Gurit congratulates Marenco Swisshelicopter on the successful roll out of its prototype. Matthias Hücke, Technical Sales Manager of Gurit (Kassel) added: «At Gurit, we are all excited about this project, and we are all counting days until we see SKYe SH09 hovering above us in the air».

With a maximum takeoff weight of 2.65 t, a fast cruise speed of 260 km/h and a range of operation

of 800 km, SKYe offers a hot and high performance, a flexible engine concept, and a low-noise signature thanks to the newly developed dynamic assemblies and shrouded tail rotor. The modularity of the cabin makes the most of the flat floor and unique high ceiling concept. It offers multiple seating arrangements for one pilot and up to seven passengers or flexible payload capacity.

The maiden flight is scheduled for 2014. SHAPE will certainly keep its eye on the SKYe.

Lifting pre-fab roofs into position

The high-speed rail link between Makkah and Medinah is scheduled to be operational by the end of 2014. SHAPE spoke with Saudi Oger, the construction consortia in charge of the Jeddah and KAEC stations, to learn more about the progress of this project and especially about the manufacture and installation of the composite roof.

Saudi Oger believes in the future of composites in architecture. Within the architectural master plan developed by Foster & Partners for all stations, Saudi Oger has opted for quite a unique approach for the production of the roofs. Souhail Alla, Project Manager Composites of Saudi Oger, explains: «Saudi Oger is one of the main contractors for the Haramain High Speed railway project. We are responsible for the complete construction of the Jeddah station. Rather than contracting the manufacture of the composite roof panels out, we decided to bring this key manufacturing process in-house, as we believe there is great future for composites in architecture. So, we set up two brand new production facilities: In Riyadh, we cut and kit the core materials and manufacture the window frames. In Jeddah, we manufacture the roof panels.»

Rudy Jurg, Regional Sales Manager for the Middle East and Africa at Gurit, adds: «In fact, this is not the first large scale architectural project for Saudi Oger using com-

posites. Building a very large dome for the Princess Nora University in record time, they have already familiarised themselves to a great extent with composite materials and respective production processes using Ampreg 21FR epoxy resin from Gurit. The dome structure was engineered by Gurit, and we worked very closely with Saudi Oger, assisting them with setting up the entire manufacturing process using impregnators and curing ovens. The Jeddah station is now another high profile building project employing composites.»

Saudi Oger decided to manufacture the repetitive composite elements close to the final construction site in Jeddah. «When you have to cover some 55 000 m², logistically this makes a lot of sense. This is an area of around 8 football fields. We don't have to transport bulky elements long-distance – a huge advantage,» Souhail Alla continued. Local production was also a prerequisite to allow us to opt for larger roof elements in order to minimise construction time. The

typical roofing panel used for the Jeddah station measures some 200 m² each – this is way more than the size of a luxurious 4 bedroom apartment!

The challenge of building apartment-size roof elements

Setting up series production for these large, lightweight panels was quite a big challenge, as many process aspects called for first-time innovative answers: «Saudi Oger manufactured special overhead cranes,» Michel Charles Lombard, Section Head, Technical Support at Saudi Oger, explains. «They include impregnators which enable us to impregnate heavy weight fabrics very quickly from above. The fabrics, too, are twice the



normal width to speed up the production process. In addition, we created automated rollers to consolidate the laminate layers prior to applying the vacuum bag.» All this special machinery and equipment was designed and manufactured in-house at Saudi Oger and extensively tested on dummy moulds to ensure the process works under real conditions. Special equipment was built in order to flip over and transport those GRP panels from the Factory to the site where they will be installed on the steel structure.



Comprehensive material testing

In addition to being lightweight, fire retardant and providing good insulation against the heat of the bright Arabian sun, the composite material used in Jeddah also needs to exhibit excellent bonding properties in combination with stainless steel covered tiles – a distinctive decorative feature of the Jeddah station. «Furthermore, in selecting the right materials, we needed to take into consideration that the air in Jeddah is much saltier than in other places. But with our extensive track record in the marine and the wind energy industries, we know how to deal with salt water and salty air,» Rudy added. All materials were extensively tested prior to their final selection for the project. In this evaluation context, Gurit and Saudi Oger worked close-

ly together for several months to produce the suite of detailed reports as required. Finally, Ampreg 21FR successfully passed all the tests. To bond the panels together, Saudi Oger chose Spabond 340FR epoxy adhesive.

According to the architectural master plan of all stations, all roofs consist of a repetitive pattern that is made up of 4 triangular panels that combine to cover one large square grid module of 27x27 m formed by the 25m high arches and pillars – the key architectural features of all station buildings. Between 32 and 72 of these modules then fit together to make one roof, depending on which station the roof is for and its size. To complete the Jeddah station, 72 structural composites modules are required. This means 288 triangular panels are needed, with each one measuring around 200 m².

In line with Saudi Oger's policy to master and control all key manufacturing steps, they also produced the moulds in-house. The huge moulds are made of multiple sectors, which were all accurately milled using a 5-axis tool. Only on

site in Jeddah were they assembled into one piece. To meet the tight construction schedule, Saudi Oger currently operates multiple roof module moulds. On average two 200 m² panels are manufactured per day. Once the panels are post-cured and have attained maximum strength and Tg, they are turned over, so that the decorative stainless steel tiles can be applied. The finished roof segments are then awaiting installation near the station.

The roof modules are easily lifted into position

Defined by the architectural master plan, the freestanding structural trees forming a mesh of elegant gateway arches and columns are built traditionally with concrete and steel.

Once the supportive structure for the main station hall and the covered platform area are up, cranes lift the finished roof elements into place and rest them on the supporting steel structure where the triangular panels connect to form the iconic vaulted roof.





Wild Oats and Giacomo both feature Gurit prepreps.

The unthinkable as the next challenge

The biggest sailing events push boat building beyond limits. Gurit is proud to have been at the forefront of boatbuilding, engineering and materials science for decades, regularly involved with the world's most spectacular sailing projects.

Gurit colleagues are closely following the top sailing events across the globe. «There are obviously two sides to this: Of course, many of us are sailing enthusiasts and we are thrilled like any other sports fan with spectacular long distance races or top notch battles

on the water. But there is also the professional side. These regattas are typically the ultimate test for many of our engineering services and materials», says Sean Jeffery, Head of Sales Gurit Asia Pacific. For decades already, Gurit is providing cutting-edge composite solutions including structural engineering design, materials and technical support services for the world's most renowned sailing and racing projects. Gurit's composite product innovations such as ultra-high performance prepreps have become an integral part of the development programs for such events. «We are proud to have been involved in projects that repeatedly have been earmarked as the world's most thrilling races at the pinnacle of global sailing,» says Sean.



From sails to wings: The demand for ultra-high compressive strength material rises.

Beau Geste was built using Gurit's low temperature cure prepregs.

In 2013 again, Gurit engineering and materials were involved in many vessels, proving their supremacy. «We believe that our high-end products such as the SE84 and SE84 Nano prepregs will continue to play important roles as the evolution of yacht design accelerates, including the development from sails to wings. This will increase the demand for ultra-high compressive strength materials.» says Sean.

In late 2013, the world famous Rolex Sydney to Hobart yacht race was held. This grueling race is a testament to Gurit's composite engineering and prepreg materials. No fewer than the top 10 finishers were built using Gurit products or composite engineering. Further to this, over the last 13 years, Gurit supplied boats have featured in the top 3 finishers of every Sydney to Hobart race.

Seven times Rolex Sydney to Hobart winner Wild Oats XI, the 100ft maxi owned by Bob Oatley and

helmed by Mark Richards, has dominated the event. Engineered by Gurit and built by McConaghy Boats in 2005, a reconfiguration was made in 2013 by McConaghy to increase performance. Now featuring dynamic stability systems (DSS) foils, the boat has a stranglehold on the race since her launch. Gurit is proud to have contributed to this winning streak with our SE84 prepreg materials.

Beau Geste, the new Botin 80 owned by renowned Hong Kong yachtsman Karl Kwok and with Gavin Brady at the helm, debuted at this year's 2013 Rolex Sydney to Hobart race. Built by Cookson Boats this racer hit the water with a very tight work up schedule. She was constructed using Gurit's SE70 low temperature cure prepreg system. After successfully completing the race, finishing in the top 5 boats against larger competitors, Beau Geste will continue to campaign on the top racing circuit.

BEING GURIT

An excellent testing ground for our prepregs and engineering services, many Gurit employees have personally competed in the Rolex Sydney to Hobart races: In 2013, Martin Hannon, Composite design engineer with the APAC office, competed on the Volvo 70 Giacomo, built with Gurit's SE84 prepreg system, for his 9th race to Hobart. Martin



comments: «A tough race, which always tests the yachts and their crew to the limits. This year was no different with the fleet taking a beating off the infamous Tasman Island. You really appreciate the power of the ocean and the punishing these yachts and their structures can take.»

Excellence Winners 2013

Gurit (UK)'s Award for Excellence scheme based on the Isle of Wight commends applicants who have achieved excellence in their chosen field, and who will use the prize money of GBP 500 and GBP 1000 for furthering their ambitions.

March 1st place – When running as an under-17 athlete, 18-year old Harrison Curling was never out of the top ten in all national UK standard cross country competitions. Now running in the under-20 category, Harrison continues to produce outstanding results, including current top 10 UK rankings in both the 10 mile and 10 km distances. Harrison will be using his award to attend a high altitude training camp in the Pyrenees.

March 2nd place – Luke Herbert, 14, and Izabella Blacklock, 15, have had an exceptional year in the pool: Izabella became the first Isle of Wight swimmer to win a medal at the World Youth Island Games, returning with a silver and two gold medals. She has recently relocated to Plymouth College to train full time with their elite swimming squad. At just 14 years, Luke



Luke Herbert



Izabella Blacklock

Herbert is already the fastest 100 m and 200 m backstroke swimmer of any age on the Isle of Wight. This year, he retained his County Champion status for all 3 backstroke events and currently holds top 10 UK rankings for his age. In July, Luke and Izabella travelled to Bermuda as first-time participants in the team representing the Isle of Wight at the 15th NatWest Island Games. Izabella broke a 12-year-old Isle of Wight record in achieving an excellent 5th place in the 100 m backstroke. As the youngest male swimmer competing, Luke swam way beyond expectations, winning through the heats to qualify for the final of the men's 100 m and 200 m backstroke and achieved an excellent 8th and 7th place respectively, made even more impressive as the next youngest swimmer to make the final was 4 years his senior!

September 1st place – Another rising star in the pool is Sid McLaren. The 14-year old followed up on Izabella's success at the World Youth Island Games to win two silver and two bronze medals – the most medals ever won by an Isle of Wight athlete at these games. She was then selected to represent the Isle of Wight in Bermuda as the youngest swimmer on the women's team, gaining valuable international competition experience.



Sid McLaren

September 2nd place – 13-year old Spencer Darlaston-Jones' long-term goal is to develop his career in theatre, television and film. Spencer has passed dance exams with distinction in Ballet, Tap, Modern, and Jazz – up to Grade 3 level in Tap and Modern.

During 2012 and 2013, Spencer has been touring the UK theatres appearing on-stage in the musical «Oliver» as Stitchem, one of Fagin's gang.



Spencer Darlaston-Jones

BEING GURIT

A thank you note

As part of the global rebranding exercise, Gurit surprised key customers with Gurit branded T-Shirts for the workshop personnel. Among the many thank you notes from our customers, we also received this photo from Jan Swar of Southern Spars, New Zealand, with the following note: «Thank you for the Gurit T-shirts that you sent. See attached pictures of the cut and laminating teams that built the Swan 105 mast and boom. At Southern Spars, we are proud to be associated with your product.»



Working anniversary in Kassel

In the fast moving world of today, two job anniversaries at Gurit (Kassel) stand out: Petra Althans looks back on 40 years, Erik Schiel on 25 years with Gurit (Kassel) and its preceding organisations. In 1973, Petra joined the R&D department of AEG Isolier- und Kunststoff GmbH, a company that was sold 20 years later to become AIK Faserverbundtechnik GmbH and subsequently AIK Advanced Composites GmbH, where Petra specialised in quality control of pre-pregs. In the new millennium, she witnessed the name change to Stesalit AG – now part of the Gurit Group – and later to Gurit (Kassel) GmbH.

Erik also witnessed all these name changes. He started in 1988 as an equipment operator. Later, he became shift leader in the impregnation works and then fore-



man in aerospace prepreg manufacturing. Since 2010, Erik has been production manager of the two Gurit worksites in Kassel, Germany, and Zullwil, Switzerland. We would like to congratulate our colleagues on their job anniversaries and thank them for all their support and hard work during these many years.

Falcon wins the Neptune Trophy

The team on board the William-Fife designed «Falcon», including Rudy Jurg, Gurit's regional sales manager for the Middle East, Africa and Benelux, have been crowned World Champions, winning the Neptune Trophy at the 2013 8mR World Championship in Helsinki.

Given the long tradition and complexity of the 8-metre class (see text box), the yachts competing in the World Championship not only raced for the International 8-metre World Cup, a trophy donated by Eugene van Voorhis in 1970, but also fought to win the Coppa d'Italia set out for the best European Yacht, the Sira Cup and the Neptune Trophy, both for boats built before 1960, and the First-Rule Cup for gaff-rigged Eights built before 1920.

Rudy Jurg is an avid sailor, annually participating in multiple regattas. Having won a number of National, European and World titles in different classes of race boats, he recently participated in the Nordsea 8mR World Championship in Helsinki, Finland. 8-metre class boats were first built in 1908 according to the International 8-metre rule. Twenty-nine boats entered the World Championship 2013, testimony to over 100 years of great boat design and evolution. Rudy Jurg sailed Falcon, a 1930-built, wooden yacht designed by William Fife, which he helped restore last year for her Dutch owner, Jan Willem Ypma. In the 2012 World Championship, the team managed a 3rd place. Having spent a consid-

erable amount of time and effort for the 2013 event, they set their aim even higher. But, so did many of the other meticulously prepared teams from 11 countries.

The whole regatta was sailed in moderate wind, sunshine, and clear water in the beautiful Helsinki archipelago. From the first day onwards, Falcon and her five Dutch and two English crew members with Jan Willem Ypma at the helm dominated the fleet with aggressive starts, optimised sail trim, and very slick crew work. Where other teams made small errors under pressure, team Falcon continued to improve by remaining focused on keeping the boat going and on tactical covers to ensure that the competition would not sail around them.

After a tremendous nine-race series with stunning results, 2-1-1-1-1-(4)-1-1-1, Falcon with Rudy Jurg as runner, mast man and spinnaker grinder, were crowned World Champions, taking home the Neptune Trophy. Having been continuously sailed for since 1890, this is one of the oldest sailing trophies in the world. Gurit congratulates Jan Willem, Rudy and the rest of the crew!





A history of formulas

The 8-Metre class has produced some of the most beautiful yachts ever built. The complex rule has seen three major amendments since it was originally adopted by the International Yacht Racing Union in 1907, and it seems that the complexity of infinite variables defining the rule still fascinates boat builders today. The overall principle was simple: as longer boats and boats with larger sail areas are faster, the sum of waterline and canvas envelope was set to be a constant. If a boat builder wanted to increase the length, the sail area had to come down or vice-versa. In the regime of the first rule (1907–1919), length and beam were treated equally. This gave builders the choice to add to the overall length by reducing the width, yielding some rather extreme designs especially when combined with the ever more popular Bermuda or Marconi rigs instead of gaff-rigs. The second rule (1919–1933) saw a big change, as the beam was discarded from the formula and replaced by a rather odd metric and imperial measurement combination calling for a minimum 8 foot beam for an 8 meter boat, or 10 foot beam for a 10 meter boat. While naval architects like Anker, Fife or Nicholson sought to gain advantages from more sail area by reducing bow and stern girth measurements, the introduction of the overlapping Genova sails took full advantage of the unmeasured headsail area aft of the mast. In 1933, the third rule re-defined the formula to

$$R \text{ metres} = \frac{(L+2d+\sqrt{S-5})}{2.37}$$

With R = the Rating; L = waterline length (LWL);
d = difference between skin girth and chain girth;
S = sail area; F = freeboard. All in metres.

This latest change increased the righting moment and the seaworthiness of the yachts and produced almost 80 new boats before World War II broke out. Although these classic Eights continued to race with a fleet on the Clyde and others in Scandinavia, France and Lake Ontario, the first new boat wasn't built until 1967: Iroquois, designed by Olin Stephens for Eugene van Voorhis, of Rochester Yacht Club USA, gave birth to the Modern classification. In 1970, after a reportedly convivial evening at the Royal Northern Yacht Club, the same Eugene van Voorhis challenged the Scots to a race and donated a trophy. This became the first International 8-Metre World Cup race in the Clyde.

Reaching out to the world



Every edition of SHAPE is sent by post to readers across the world. For some time, the preparation has been in the very competent hands of physically handicapped adults. Three years ago, zeka, which provides support, therapy treatment and schooling for handicapped children in the Swiss canton of Argovia, began offering specially equipped apartments for physically handicapped adults. There, they can live as independently as possible with competent support available nearby. zeka also founded kontor, an office support centre, where the inhabitants of zeka's special apartment block and handicapped employees who live with their parents or elsewhere can work. The market-priced service offering of kontor comprises document handling and letter shop services, but also includes more complex jobs, such as accounting, preparing CV resumés, or handling the yearly declarations for taxpayers.

We at Gurit are aware that some people are not able to perform all types of jobs and that the structure, appreciation, and social interaction of work are important in everyone's life. kontor manager Giovanni Pascariello knows the individual capabilities of his colleagues and structures jobs accordingly: «The dispatch of SHAPE involves various jobs. While some of our colleagues are very good with computers and create address labels from the spreadsheet files, others stick the labels on, sort and pack the magazines, or organize the mass mail dispatch.» Bernhard Schweizer, Group Communications and Investor Relations at Gurit, added: «Gurit is very pleased with the professional service of kontor. Project handling and execution is seamless. We understand that it is helpful, for instance, to send the

address files a couple of days ahead of time. This gives kontor more flexibility to structure and prepare the job. Then, the actual packaging of the individually mailed copies only takes a day. Amazing!»



«Our colleagues like SHAPE, as it is a colourful magazine with great pictures and articles from all around the world», said Sonja Rohr of kontor. «We look forward to the next edition.»



The mechanics of bonding

State of the art fracture mechanics analysis helps building lighter and stronger wind turbine blades, as the required amount and strength of the applied adhesives can precisely be selected.

Most large wind turbine blades are typically manufactured by pre-curing large composite components such as spars, shells or shear webs and then adhesively joining them with a structural bonding agent. Historically, these adhesive joints have been designed using a shear strength approach that involves measuring the shear strength of the adhesive on lap shear coupons and designing the adhesive joints such that the calculated shear stresses are lower than the measured shear strength with safety factors applied.



This approach, however, has a couple of limitations as

- it does not address loads in other directions applied to the joints
- the lap shear coupons inherently contain peel loading which may not exist in reality



- it is difficult to test the effect of realistic manufacturing imperfections such as voids, due to the small coupon size.

These limitations necessitate the use of relatively high safety factors that still may not prevent the failure of the adhesive joints.

Fracture mechanics analysis provides a deeper understanding, ...

Gurit likes to apply fracture mechanics as an alternative and more precise approach. It studies the growth of cracks in materials, so defects are an inherent part of the analysis. For an adhesive, the



critical fracture toughness is the amount of energy required to create an area of crack and is measured using test coupons. The «driving force» to grow the crack is the elastic strain energy that is stored in the blade due to the applied loads. If the strain energy released as a crack grows is greater than the critical fracture toughness, the crack will continue to grow.

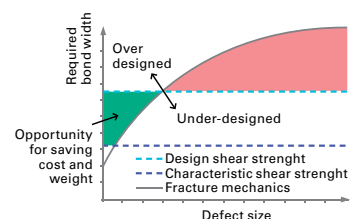
Calculating the strain energy released is a complex endeavour for all but the simplest geometries.



This analysis calls for sophisticated methods such as the Virtual Crack Closure Technique (VCCT). This technique uses a Finite Element (FE) model of a blade with a crack in an adhesive joint and allows the strain energy released as the crack propagates to be calculated and compared with the critical fracture toughness of the adhesive.

... reduces the amount of adhesives used, and yields more reliable blades.

Using fracture mechanics addresses all of the loading components and addresses both defect size and location which allows the use of lower safety factors. When this approach is used in combination with a toughened adhesive such as Spabond 340LV it can deliver a blade that is both more reliable and requires less adhesive.



Gurit Agenda 2014

Gurit will showcase its wide range of material packages, engineering solutions and technologies at a trade show near you. Our teams look forward to meeting you and introducing you to the latest in advanced composites at the following shows:

- **JEC Europe, Paris / France**
11–13 March 2014, Focus: All markets
- **ALM (Automotive Lightweighting Manufacturing), Gaydon / Great Britain**
25–26 March 2014, Focus: Automotive
- **Aircraft Interiors Expo, Hamburg / Germany**
08–10 April 2014, Focus: Aircraft
- **Sanctuary Cove International Boat Show, Queensland / Australia**
22–25 May 2014, Focus: Marine
- **AIA 2014, Chicago / USA**
26–28 June 2014, Focus: Architecture
- **China Composites 2014, Shanghai / China**
03–05 September 2014, Focus: All markets, Engineering
- **Innotrans, Berlin / Germany**
23–26 September 2014, Focus: Transportation, Engineering
- **Auckland On Water Boat Show, Auckland / New Zealand**
25–28 September 2014, Focus: Marine
- **Composites Europe 2014, Düsseldorf / Germany**
07–09 October 2014: All industries, Engineering
- **CAMX (Composite and Advanced Materials Expo), Orlando / USA**
14–16 October 2014, Focus: All markets, Engineering
- **EURO BUS EXPO, Birmingham / Great Britain**
05–06 November 2014, Focus: Transportation, Bus
- **METS 2014, Amsterdam / The Netherlands**
11–13 November 2014, Focus: Marine
- **Composites Engineering Show, Birmingham / Great Britain**
11–12 November 2014, Focus: All markets, Engineering
- **India Composites Show, Mumbai / India**
10–12 December 2014, Focus: All markets, Engineering

For details on Gurit's sales and distributor network, please consult:

<http://www.gurit.com/sales-and-distributors.aspx>

For general enquiries, please visit: <http://www.gurit.com/contact-form.aspx>



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