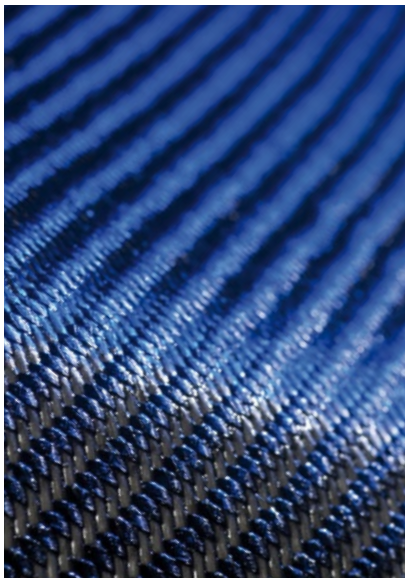
Gurit

The Complete Composite Solution for Wind Energy in China



RED MAPLE

Gurit

www.gurit.com/windenergy

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Introduction

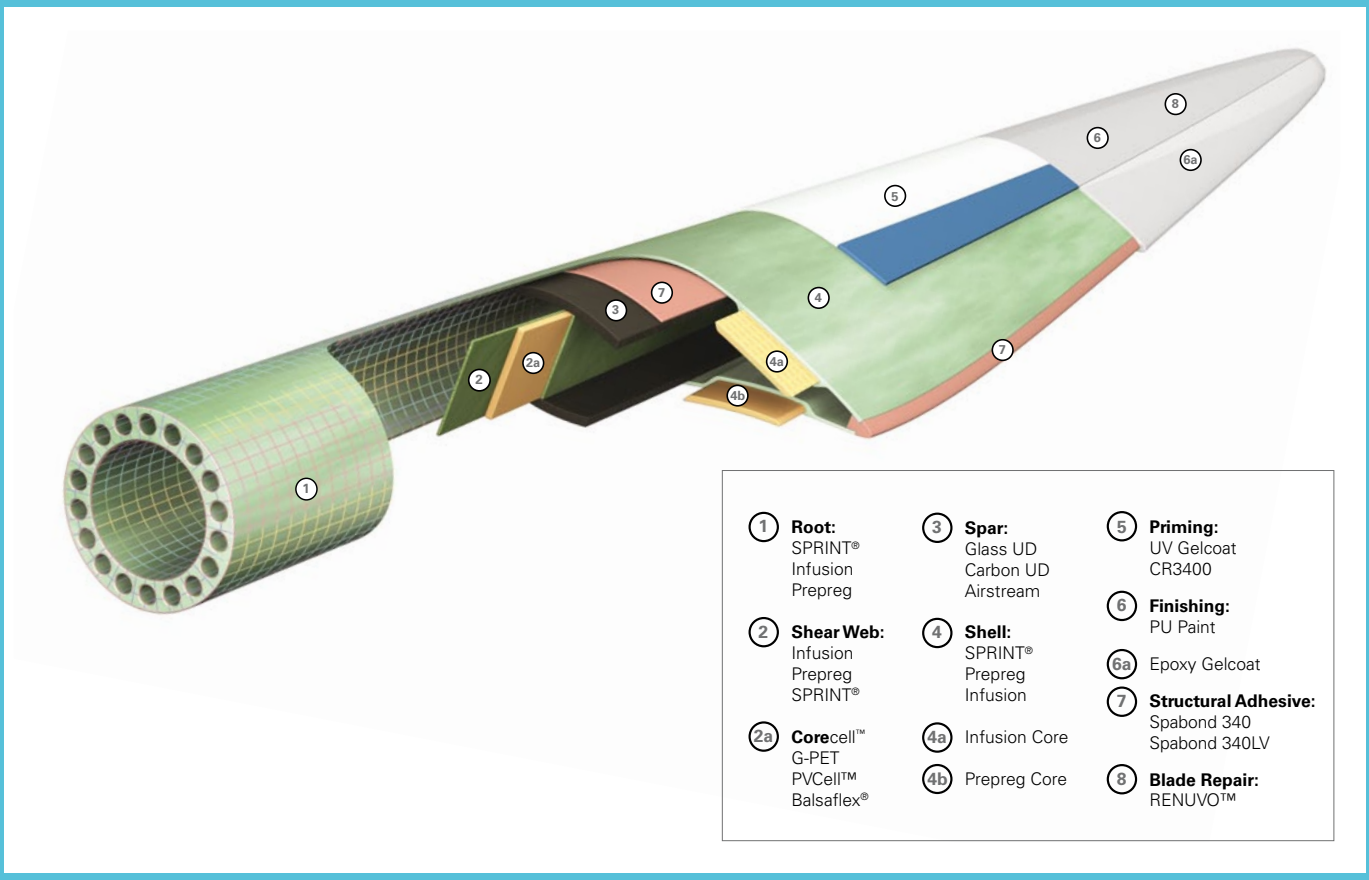
Gurit is a leading global supplier of advanced composite materials for the wind energy market. With over 15 years experience, Gurit has developed a broad range of award winning products and solutions for the wind energy market and is unique in covering both infusion and prepreg blade technology with the capability to supply all the relevant materials needed for building a composite blade.

The successful creation of a large composite structure needs specialist knowledge of structural design, materials technology and composite processing. Gurit is in the unique position of possessing all of these disciplines in one integrated technology centre, maximising the potential for innovation and rapid development of technology solutions. What ever the blade technology, Gurit has the product and development capability to meet the customers requirements and expectations.

The phenomenal growth of the wind energy market has driven the global expansion of Gurit's operations. In 2007 Gurit became the first global supplier of prepreg to the wind energy market when a new facility was opened in Tianjin, China. Gurit Tianjin is now ISO 9001, ISO 14000 and OHSAS 18000 certified. In 2009 Gurit acquired Chinese wind blade mould manufacturer Suzhou Red Maple, now known as Red Maple, the Tooling business of Gurit, as well as a majority stake in the Chinese structural foam company, China Techno Foam Co., Ltd. in Qingdao. In March 2011, Gurit also aquired a majority stake in balsa material producer Balseurop, to complete its core offering for the wind energy market.

Having a manufacturing capability for prepreg, SPRINT®, structural core, adhesives and infusion systems in Asia, North America and Europe, Gurit is ideally positioned to provide local service to its global customers.

This brochure outlines Gurit's complete composite solution for wind energy in China.



The Total Materials Package

Corecell™

Corecell™ T-Foam is a high performance structural foam based on SAN polymer (Styrene AcryloNitrile). With mechanical properties meeting most customer specifications, **Core**cell™ T-Foam is a suitable and cost-effective alternative to PVC foams.

Main Benefits:

- Properties meeting most customer specifications
- Lower resin uptake than PVC cores offering cost and weight savings
- Direct replacement for PVC cores
- Availability from production facilities located in Tianjin, PRC
- Available in typical infusion formats and in kitted form
- Germanischer Lloyd (GL) and Det Norske Veritas (DNV) approved

Corecell™ T-Foam has a proven track-record having been used in thousands of wind turbine blades produced in the US, Europe and Asia. Examples of use of T-Foam in wind turbines are available on request.

G-PET

G-PET is a structural foam based on the cost-effective polymer PET.

Main Benefits:

- Good economy of production through automated extrusion process and cost effective raw materials
- Recyclable, reducing the cost of waste
- Lower resin uptake than Balsa
- Available up to 160mm sheet thickness without bonding
- Mechanical properties meeting most customer specifications
- Temperature resistance for prepreg or high exotherm processes

G-PET is used extensively in wind turbine blade manufacture. G-PET is manufactured in Tianjin, PRC and is available in sheet, grooved/perforated forms or kit-cut to customers' desired shapes.

PVCell G-Foam

PVC Foam has been the core material of choice for wind blade producers around the world. Gurit PVCell G-Foam provides new choice and availability of high quality PVC foam for sandwich composite applications, particularly to wind blade manufacturers in China.

PVCell G-Foam is produced at a Gurit production facility in Qingdao, PRC. Production facilities are rated ISO9000 to offer confidence in quality. Due to production within mainland China, Gurit can offer short lead-times, local technical support, and low supply chain risk for Gurit's customers.

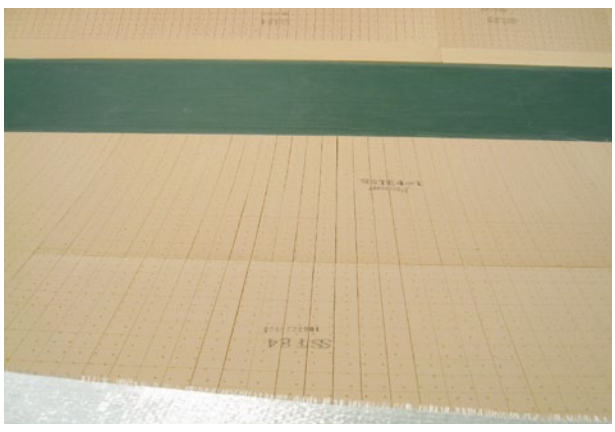
PVCell G-Foam is a closed cell, cross-linked polymer foam that exhibits high stiffness and strength to weight ratios with superior toughness. It has excellent properties meeting most customer specifications, particularly compressive and shear properties, one of the most important design criteria in structural composites.

Main Benefits:

- PVCell G-Foam has been specifically developed for vacuum infusion applications and is compatible for use with epoxy, polyester, and vinylester resin systems
- Can be used in practically every sandwich composites application such as wind energy, marine, transportation, infrastructure, and industrial markets
- Consistent high quality, excellent adhesion, excellent chemical resistance, low water absorption and good thermal insulation
- Can be supplied with grid-scored, double cut and 'infusion' grooved/perforated forms

For those involved in series production, PVCell G-Foam can be supplied in kits where each piece is pre-cut, shaped, as necessary, and numbered to fit exactly into its designated place in the mould.

The PVCell G-Foam range has received DNV certification, and GL certification for G45-G100 .



G-Balsa

G-Balsa is a premium quality end-grain Balsa Core material suitable for use in a wide variety of structural sandwich applications.

Main Benefits:

- Compatible with vacuum infusion applications using various resin systems
- Micro-sanded with a special coating applied to reduce resin absorption during vacuum infusion process
- A wide operating temperature range and is suitable for thick laminate parts, and is compatible with high exotherm resins

Balsa is an abundant natural resource in Ecuador. The end-grain configuration of honeycomb-like cells exhibits superior physical properties unmatched by many core materials in the market. The rich Ecuadorian soil, ideal rainfall and tropical sun light conditions allow rapid growth of Balsa trees reaching around 28 metres in 5 to 6 years.

G-Balsa is available as plain sheets, contoured with scrim, grooved, and perforated, as well as in kits where each piece is pre-cut, shaped, as necessary, and numbered to fit exactly into its designated place in the mould. G-Balsa is GL qualified.

Core Kitting

Gurit has a comprehensive package of CNC and semi-automatic machines that can produce the full range of sheet and kit products required for the wind energy industry.

Plain sheets can be processed and supplied with grooves, knife cuts or holes to suit all Infusion and prepreg blade manufacture. In addition, many customers prefer to be supplied with ready-made kits that are precision machined so as to ensure a perfect fit to the mould profile.

Main Benefits:

- Simple inventory control of core kits
- Quick and easy lay-up in the mould
- Maximised mould utilisation
- Blade process and weight stability
- Avoids use of additional resin to fill gaps in hand cut core
- Consistent high quality day to day

RENUVO™
Blade Repair System

The RENUVO™ blade repair system offers a fresh and novel approach to the maintenance and repair of today's wind turbine blades. Addressing many of the limitations associated with current blade repair materials and techniques, RENUVO™ can be used on epoxy and polyester blades for damage that has been caused in the blade factory, during transportation or in service.

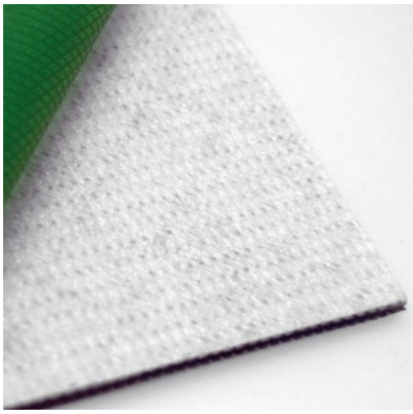
RENUVO™ uses UV light from specially-designed lamp equipment to achieve full cure in just a few minutes and is designed to be handled at temperatures as low as 5°C. This greatly widens the weather window for carrying out repairs, and dramatically reduces the turbine downtime. The RENUVO™ materials are also very easy to handle, requiring no mixing or awkward hand-impregnation of heavy glass fabrics.

Main Benefits:

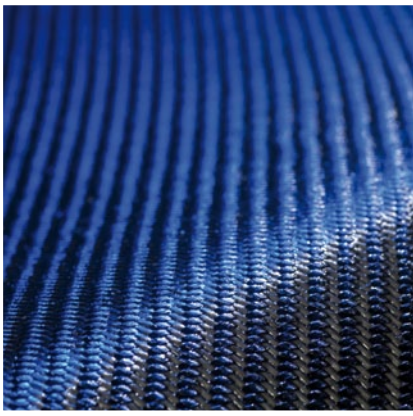
- 50% reduction in structural repair time
- GL certified product range
- Extended weather window for repair from +5°C
- Zero postcure for structural repair

Prepreg and SPRINT®

Gurit offers a range of prepreg and SPRINT® products for blade components with higher strength and fatigue properties giving weight saving and enabling larger blades.



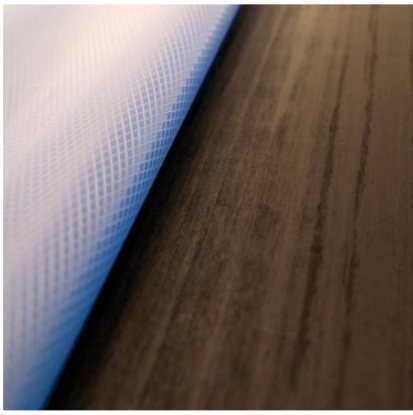
Pre-impregnated materials (prepregs) are fibres or fabrics into which a pre-catalysed resin system has been impregnated through a controlled, automated process. The accuracy of Gurit's process ensures that laminates produced from prepregs have higher properties than can be achieved by infusion techniques. Furthermore, this technology allows the use of very tough and strong resin systems that would not be feasible for use by infusion.



SPRINT® is a patented material format that allows high quality composite components, with high mechanical properties and very low void content (typically 0-0.5%) to be produced rapidly and economically.

Prepreg and SPRINT® Benefits:

- Much higher characteristic strength values for weight saving in strength driven areas vs. infusion
- Far higher fatigue allowable values
- Cost saving vs. infusion
- Enables thick laminate construction with low exotherm
- A clean and healthy work environment
- Efficient processing without consumables waste
- Improved fibre alignment over infusion



Prepreg and SPRINT® materials are available with a range of reinforcement combinations using uni-directional, woven and stitched, carbon and glass.

Engineering and composite processing support is available to optimise your design.

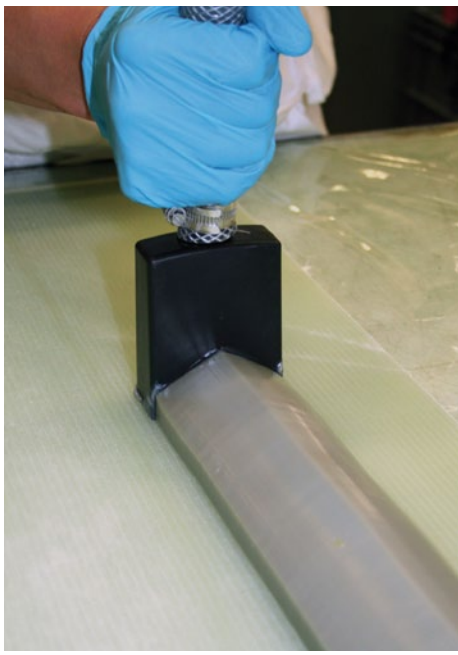
Spabond 340LV

Spabond 340LV is a high performance adhesive for bonding wind turbine blades. It is a cost-effective system with 10% lower density than competitive systems and high fatigue/crack resistance.

Spabond 340LV is GL and Aerodyn approved with over 11,000 blades, 40m+ having been bonded using Spabond 340LV providing a proven track record of performance and durability. The system has a simple 2:1 mix ratio by weight and volume and has been specifically designed to retain thixotropy when being mixed/pumped at high output rates. Spabond 340LV is available in a range of sizes from convenient 900ml cartridges for finishing/repair to 200 litre drums for machine mixing/dispense.

Main benefits:

- High strength & toughness
- High fatigue resistance – improved crack resistance when compared to competitive systems
- 10% lower density when compared to glass filled systems
- Range of working times
- Can be mixed and dispensed at up to 20kg/minute
- Low exotherm & shrinkage in thick bondlines
- Sag resistance up to 25mm on a vertical surface
- Compatible with a wide range of mixing/dispensing equipment
- Resin & hardener components are pigmented to give a visual indication of mix quality



Gurit can supply an adhesive/mixing machine package, which removes the need to invest in expensive mixing machines and ensures a consistent high quality adhesive mix.

Local supply from Gurit (Tianjin) combined with a team of process engineers to support the use of Spabond 340LV ensures that Gurit is well placed to support customer needs.

PRIME™ 20LV

PRIME™ 20LV is a low viscosity epoxy infusion resin designed for infusing large parts with complex reinforcements.

The exceptionally low exotherm characteristic of PRIME™ 20LV allows thick sections to be manufactured without risk of premature gelation due to the heat of exothermic reaction. This low exotherm will also help to extend the life of mould tools.

PRIME™ 20LV is GL and Aerodyn approved and over 7000 blades, 40m+ have been manufactured using PRIME™ 20LV providing a proven track record of performance and durability.

It has been used successfully for the single-operation moulding of components ranging from narrow shear webs and spars, up to 60 metre blade shells. It achieves excellent mechanical and thermal properties from a moderate (50°C) postcure.

Main Benefits:

- Low viscosity – 220cP at 25°C
- Low exotherm in thick sections
- Excellent mechanical & thermal properties after postcure at 50°C
- GL & Aerodyn approved
- Proven track record in the manufacture of large, 40m+ wind turbine blades



Infusion process using PRIME™ 20LV

Red Maple, the Tooling Business of Gurit

Established in 2007, Red Maple is the largest wind blade mould manufacturer worldwide, producing over 40 mould sets a year. Red Maple's ISO9001 facility is situated in Taicang, China, and has over 600 skilled employees dedicated to the design and manufacture of high quality tooling, using innovative technology. With complete vertical integration of the mould production process, Red Maple sets the new benchmark for tooling system cost and delivery time.

- Wind blade master plugs
- Wind blade moulds
- Hydraulic mould closing systems
- Hydraulic mould clamping systems
- Mould heating systems
- Jigs & fixtures

Quality, Manufacturing and Engineering

Red Maple can offer a variety of high quality moulds appropriate for any production process at an affordable price.

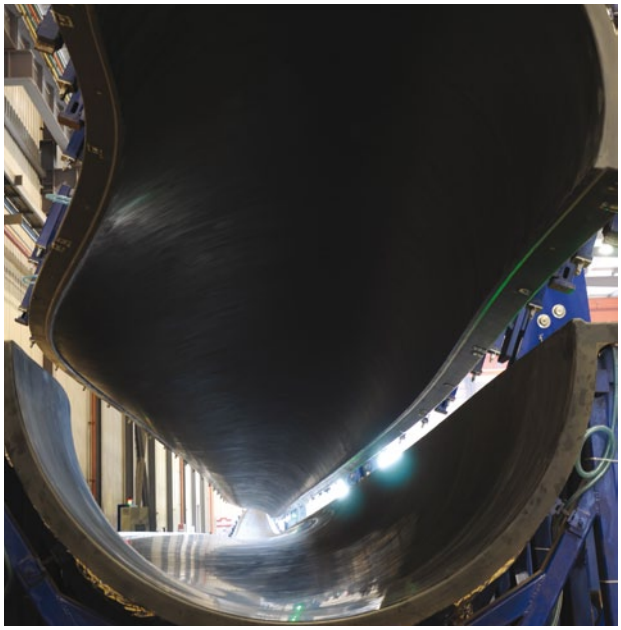
Available technology:

- Mould produced with or without gelcoat, depending on customer manufacturing process
- Epoxy resin with Tg of 90˚C, 100˚C, 130˚C or 160˚C can be used, or alternatively vinylester
- Mould main shell produced by infusion or hand lamination at customers' request

The Total Mould Package

- Mould strengthened by composite core materials based on customer requirements
- Electric, liquid or air heating options
- PC based heating control, monitoring software
- Mould frame is designed using FEA software
- Welded steel frame, for long life and stable support of the shell
- Patented mould shape adjustment system

Master Plug



Red Maple has two of Asia's largest 5-axis CNC machines, operating continuously to enable Red Maple to build master plugs with extreme accuracy and speed unattainable by other methods.

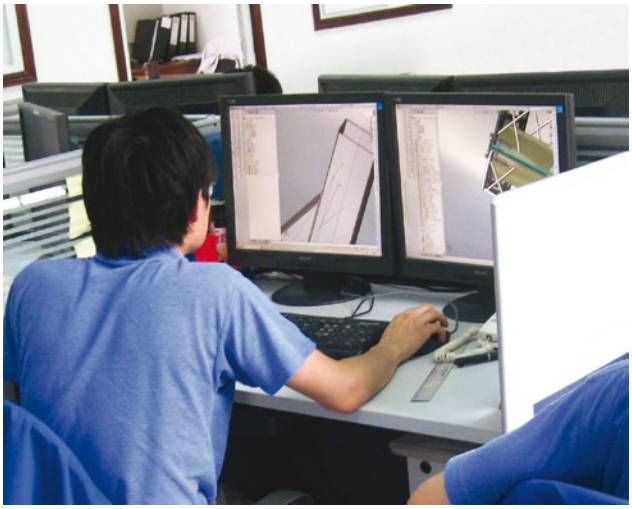
The CNC machines can produce plugs up to 65m in length in one piece. This operational envelope in combination with the high level of speed and precision allows rapid plug manufacture and ensures that all components; shear webs, spar caps, root inserts fit first time without costly adjustments or the use of fillers.

Red Maple can offer the following features:

- Small 5 axis CNC with working envelope 36m x 8.2m x 4.5m
- Large 5 axis CNC with working envelope 65m x 7.2m x 5.8m
- Red Maple exclusive all-steel construction guarantees long life and moisture resistance
- Section accuracy +/-0.5mm
- Linear runout +/-0.5mm
- Overbite tolerance at leading edge of blade mould achieved <+/-1mm
- Epoxy machining paste with Tg of 60-65˚C
- Tg of epoxy paste verified by in-house DSC machine
- An alternative EPS foam base is available for small plugs and moulds
- Solid frame, suitable for international shipping and easy lifting

The Total Mould Package

- Perfectly smooth finish to ensure excellent mould surface is obtained
- Guarantee a glossy polished finish in the as-delivered condition
- Tested to guarantee no vacuum leaking, suited for resin infusion of the mould
- Special weatherproof surface protection coating for shipment
- Red Maple have used single plugs to produce up to 14 blade moulds without major repair or loss of accuracy



Market Leading Mould Package

The large team of design engineers at Red Maple provide fast and efficient mould design, with the flexibility to deliver to a wide range of customer specifications.

- Red Maple provides the entire scope of mould system delivery in-house, and operates on a 6 day, multi-shift basis. The typical lead time for shipment of a 45m mould with standard features is a market-leading 12 weeks from receipt of the geometry
- Delivery time is only 18 days for additional moulds
- Red Maple ships completely assembled and qualified tooling packages, so installation of a mould set at the customer site can usually be accomplished in 3-8 days

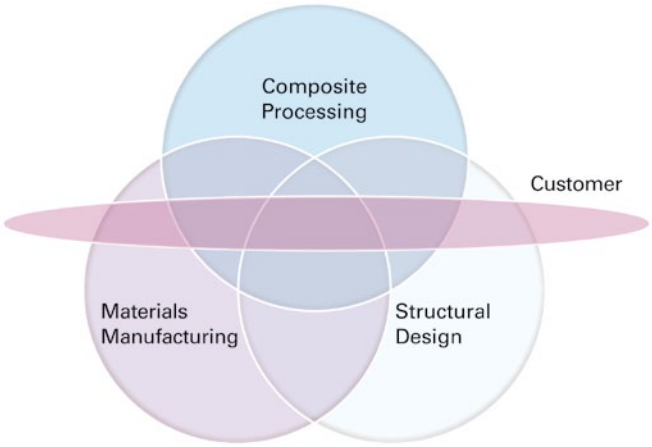
Taking advantage of labour cost savings, the excellent supplier base in China, and economies of scale, Red Maple can offer a more sophisticated mould system, at a lower price.

With long experience of wind turbine blade mould production around the world, Red Maple has brought advanced mould building and mould accessory technology to China. With its location in close proximity to Shanghai, it is ideally suited to both the increasing domestic market and export markets.

Engineering

Gurit's Unique Technology Platform

The successful creation of a large composite structure needs specialist knowledge of structural design, materials technology, composite processing and tooling. Gurit is in the unique position of possessing all of these disciplines, maximising the potential for innovation and rapid development of technology solutions.



Structural Engineering

Gurit's Structural Engineering Department (formerly SP Technologies Ltd.) was formed out of SP Systems in 1988. With the acquisition of High Modulus in 2009, Gurit engineering now has one of the largest, most experienced composite engineering teams in the world, across a range of target markets.

In the last 10 years Gurit has developed a strong structural engineering capability to support its wind energy customers, designing blades from 30 to 55 m in length. The design of these structures has included the use of both carbon and glass for the main structural elements and also the development of novel root joint solutions. Designing for both prepreg and infusion material technologies Gurit has a wealth of experience to provide a range of structural engineering solutions for its customers.

Technology Partnerships

As the wind energy industry has expanded, Gurit has developed a comprehensive range of products and technical services, to support our customers and their chosen blade technology. The dramatic change in blade length in the last 10 years has demanded a high level of innovation in materials, design, and processing, driving increased collaboration between OEMs and suppliers. Gurit's strength in innovation, and impressive portfolio of patented technology, has lead to the involvement in many high profile projects, providing competitive advantage for Gurit's customers.

Composite Processing

With resources supporting all Gurit's major markets, the composite processing team can help you to incorporate Gurit materials into new or existing processes.

Experts in all aspects of processing composite materials, from wet lamination, resin infusion and prepreg materials, assistance is available with setting up new processes, stepping up the technology ladder or optimising existing manufacturing processes. A full understanding of the Gurit material range, including epoxy resins, adhesives, core materials, coatings and structural prepregs allows a holistic approach to material selection and to solving processing problems.

- Material selection advice
- Process optimisation
- Risk analysis
- General advice and guidance of using Gurit composite materials
- Generation of processing guidelines
- Component or process failure analysis
- Quality validation

The Composite Processing teams in Asia are aligned to Gurit markets of wind energy, marine & transportation. The team is multi-disciplinary but with aspects of specialism in the various common processing methods. Fully supported by the global Composite Processing team, totalling 20+ engineers on 3 continents, the local team is responsive to the needs of Chinese customers, with 3 full time, native Mandarin speaking engineers.

The Composite Processing team are integral to Gurit material product development and ensure that material introduction or improvement is performed with customer manufacturing techniques in mind.

The Composite Processing team works closely with Gurit's Prototyping facility, which has the capability to prove out new concept materials, manufacturing techniques or component designs with fully trained and experienced composite technicians.

Local support, Global products.

More Information

For more detailed information on Gurit's offerings within the wind energy market, please visit: **www.gurit.com/windenergy** or **www.gurit.cn** to view the following:

- Product data sheets
- News/case studies
- Events schedules
- Corporate videos
- 'How to' videos
- Composite guides
- Product brochures

For pricing or other enquiries, please contact windenergy@gurit.com

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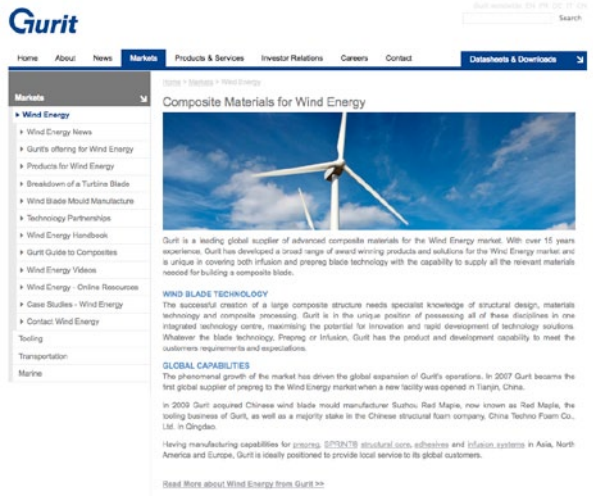

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