



Harnessing Nature's Power

Hexcel's composite materials, processes and solutions for wind turbine blades



Harnessing Nature's Power



Hexcel is a leading global supplier of advanced composite materials to the wind energy market and has supplied more than 20,000 tonnes of composites to wind turbine blade manufacturers over the last twenty years. Our composite technologies have enabled blade lengths to increase to 75 metres plus and supported wind power to be the world's fastest growing energy source.

We work closely with our customers to develop products and processes that are tailored to their specific requirements. This approach has enabled us to develop technologies such as:

- Prepreg materials and process solutions to optimise throughput by faster curing at lower temperatures.
- Fibre-reinforced matrix solutions for rapid cost-effective processing.
- Unidirectional carbon prepregs for critically loaded structures
- Materials for root ends and Polyurethane solutions for cost efficient manufacturing of nacelle housings.

Hexcel is one of the few suppliers of composites for wind energy to manufacture carbon fibre in-house. This knowledge, combined with our dedicated weaving facilities, enables us to design composite reinforcements in carbon and glass, or hybrids of the two. We are the composite specialists, with dedicated R&T facilities in Europe and the USA. Our global technical support team assists with material selection; processing and can provide training to those who are new to composites technology.

Empowering technology

supplying technology solutions

Hexcel has developed a broad range of products and solutions benefiting from synergies with other cutting edge technology markets for composites including aerospace and space and defense.

During the rapid growth of the wind energy market Hexcel has been on the forefront of developments supporting expansion by supplying technology solutions rather than just materials. To support the wind energy market Hexcel has dedicated manufacturing facilities in Asia, Europe and the USA.



Manufacturing a large composite structure

A wind blade is a component for a machine designed to direct and concentrate energy from the air into a wire that connects the turbine generator to an electrical grid. The cost of such energy is therefore dependant on advanced and cost effective solutions to manufacture very large composite structures like wind blades.

Prepreg is a glass or carbon fibre reinforcement that is impregnated with resins such as epoxies. They are supplied in roll form and cured with the application of heat and pressure to produce high quality laminates with superior stiffness and strength – at low weights. Prepreg is an ideal cost-effective technology for the manufacture of large composite parts as the process is readily automated and the materials are easy to handle.

Carbon fibre prepregs are a cost effective option for very large diameter blades, as less material is required to achieve the strength and stiffness of glass structures. Hybrid reinforcements of glass and carbon are also a potential option.

Hexcel has extended its resin range for wind energy, to meet the requirements of customers seeking to further reduce production times and costs and smooth their production output. HexPly® M9G resin systems are formulated epoxy systems suitable for low pressure moulding processes. The resin systems are highly versatile, permitting a range of processing temperatures from 85°C up to 150°C. HexPly® M9G systems are a further development of Hexcel's well established M9 range, already widely used to manufacture wind turbine blades.

With the new HexPly® M9G resins, Hexcel continues the success of high performance composite materials specifically developed to meet the challenges facing wind turbine producers.



Newly developed HexPly® M9GF products are diuron free, making Hexcel ahead of the game in anticipating future environmental legislation.

Hexcel ahead of the game



Benefits of HexPly® M9-family materials:

- optimised structural design
- consistent fibre volume ratios
- lower and consistent blade weight
- pure UD materials with optimised performance/cost ratio
- high strength and fatigue properties
- short total processing and cure cycle
- clean working environment
- low exotherm – enabling curing and co-curing of multi-ply laminates, e.g. carbon with glass
- minimise stresses caused by differences in thermal expansion

Carrying the load

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A wind blade is a structural beam that throughout its operating life is subjected to considerable lift forces on its aerodynamic profile. Stiffening of the blade is therefore essential to resist bending. The longer the blade, the higher the performance demands on such load carrying structures. The stiffness of the material in the structural beam is crucial as it prevents the blade from striking the tower when rotating. The structural integrity of the wind blades depends on the combination of composites used to build the load carrying structures and the highest quality materials are therefore required for such applications.

Hexcel has developed an optimised range of prepregs and other fibre-reinforced composites for spar/shear web construction, including UD reinforced carbon and glass materials. Hexcel's innovative and patented carbon UD materials utilising Grid-Technology allow manufacturing of very thick carbon UD laminates by vacuum bag technology resulting in excellent void-free laminate quality.



A leader in carbon fibre technology, Hexcel has the know-how and experience of technologies related to introduction of carbon fibres into large scale structures requiring, for example, lightning-strike protection.

Connecting the blade

The wind blades are fixed to the hub via a bolted connection that allows them to be removed. Most blade roots consist of a thick solid laminate with studs or T-bolts either screwed or bonded in.

Care must be taken during the curing of the composite structure as the high thickness in the laminate sections could lead to a build-up of high exothermic temperatures. For this reason many manufacturers make the root as a separate component and bond it into the structure.

Blade roots are therefore a critical area of the blade, requiring a very high quality of laminate. Hexcel has developed an optimised range of prepregs and other fibre-reinforced composites for root construction which allow the manufacturing of

root sections in controlled and cost efficient way. This allows smaller root diametres and lighter root ends due to superior mechanical performance from the prepreg construction, resulting in potential savings in hub design.

high strength
and fatigue
properties



Optimising thick structures

Polyspeed® pre-cured glass/carbon/epoxy laminates are used in conjunction with prepreg in a vacuum bag lay-up to improve the quality and optimise the structure of cured stacks. Polyspeed® pre-cured laminates are available in woven or unidirectional constructions fully supporting the mechanical performance of vacuum bag cured structures. As the materials are already cured when introduced in the lay-up the final exotherm upon curing can be reduced, additionally buckling, waviness of long lay-ups can be avoided completely thus providing optimized fibre orientation in large scale unidirectional lay-ups.

Our Polyspeed® grid laminates which are woven glass fibre epoxy laminates with an open grid structure allow liquid resins or reactive foams to flow through the lay-up structure. Grid laminates are ideal for combined technologies

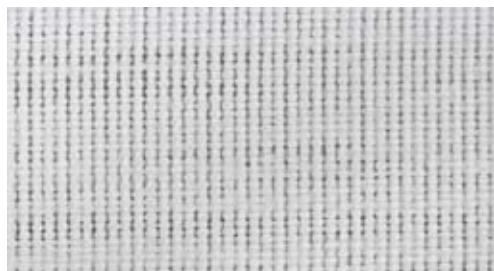
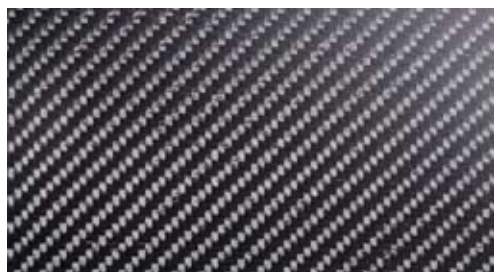
where reactive liquid systems need to be combined with solid, already cured, composite parts. They enable large structures to be manufactured cost-effectively by combining infusion technology with laminates or other pre-cured load carrying structures such as pultruded components.

Grid laminates provide mechanical fixing for dry reinforcements which need to be infused and contribute to the final mechanical performance. They reduce the use of auxiliary materials and can also reduce the amount of dry reinforcement required in wet processes as grid laminates contribute to the structural performance.

Polyspeed® laminates are available in a wide range of fibre areal weights from 500 g/m² to 1600 g/m² and in widths from 38 to 1270 mm.



HexFIT® products contain a film of prepreg resin which is combined with dry fibre reinforcements. HexFIT® is processed by applying heat and vacuum, which activates the resin, enabling it to flow and infuse the reinforcement. HexFIT® provides a quick and cost-effective way of producing large, thick laminates minimising porosity. Hexcel's HexFIT® is a very effective way of manufacturing blade components, ensuring full infusion of the reinforcement.



optimised structural design

HexFIT® Benefits

- optimal material combinations
- good fibre alignment, easy to handle and drape
- vacuum bag/oven or press cure
- controlled impregnation – no dry residual fibres
- good air release and full infusion of reinforcement
- void free laminates
- compatible with other processing methods (e.g. LRI)
- higher compression strength due to use of non-stitched non-woven reinforcements
- dry resin cleaner to use
- easier processing than prepreg

Polyurethanes in wind turbines



Modipur® is a range of different Polyurethane (PU) formulations for Wind Energy applications.

Hexcel is able to formulate specific PU core foams for many wind energy applications and has access to a wealth of history and experience in PU technology built up over 30 years. Bespoke products are developed to respond to customer needs.



Materials processing and testing

A world leader in prepregs and composites for wind turbine blades, Hexcel is also a specialist in integrating materials into customer processes.

Large scale components like big wind blades cannot be manufactured by purely manual processes anymore due to the vast dimensions of parts. Hexcel has a wide range of expertise in the integration of automated technologies into manufacturing processes and is focused on providing innovative solutions to the wind energy industry. Hexcel has also developed strong

partnerships with a number of companies and institutes including universities and internationally acknowledged composite testing companies for developing, demonstrating and proving novel materials and concepts. Hexcel material testing facilities have achieved GL accreditation.



integrating materials into customer processes



For more information and the full range of data sheets for Hexcel's composite materials for wind energy please visit www.hexcel.com

To contact us please find our list of sales offices at: www.hexcel.com/OurCompany/sales-offices

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