



The Chemical Company

RELEST® WIND

Coating Systems for Windenergy



RELIUS
Industrial Coatings

THE CHEMICAL COMPANY



BASF is the world's leading chemical company. Our portfolio includes chemicals, plastics, performance products such as coatings, agricultural products and fine chemicals, as well as oil and gas. Our objective is to make the future of our customers and business partners more successful with our products and services.

BASF Coatings is the global player of the coatings industry with its Automotive OEM Coatings, Automotive Refinish, Industrial Coatings and Architectural Coatings business units. We have pioneered innovation and sustainability in this industry for decades with focused expertise and cultivating close, cooperative partnerships with our customers.

In the Industrial Coatings area, we differentiate between Pre-Coatings and Post-Coatings. Coil coatings, for example, are a type of Pre-Coatings. They are used to coat steel and aluminium coils, prior to further processing in the construction, appliances and automotive industries.

Post-Coatings are used in an enormous range of industrial applications; for example, they are utilised for coating household appliances, wind turbines and for providing heavy corrosion protection in the shipping sector and on land.

For us, developing the future together also means combining tried and tested products and services successfully with innovations. RELIUS products are a logical and ideal complement to the BASF portfolio.

WIND ENERGY – BASF EXPERTISE

Our strategy focuses on:

- *Global presence*
- *Innovative and intelligent solutions*
- *Close partnership with our customers*
- *Sustainable behaviour*

Wind power is an important source of renewable energy. Today, wind turbines represent an important contribution to power generation. BASF supports the continued development of wind energy as a climate-friendly energy source. Accordingly, we are your global partner for innovative, high-quality products and solutions for efficient manufacturing of modern rotor blades, foundations and towers as modules for wind turbines. Besides the coating systems described in this brochure, BASF supplies Baxxodur® brand two-component systems, consisting of epoxy resin and hardeners for rotor blade production, as well as special grouting materials such as MASTERFLOW 9500® for towers and bases. If you want to learn more about our broad product portfolio for the wind energy industry, please visit our website at: www.windenergy.basf.com

Our ability to develop intelligent solutions makes our customers' products successful in their respective markets.

A decisive contribution: BASF's coating systems by RELIUS. Since 2007, RELIUS has been a part of BASF's Coatings Division.

Our coating systems, marketed under the new RELEST® brand name, have been designed specifically for the industrial sector. We have been refining them successfully for many years. They offer reliable protection for metal and plastic surfaces – even for those exposed to the harshest conditions. Our coatings are therefore an important component for durable, functionally reliable and flexibly designed products.

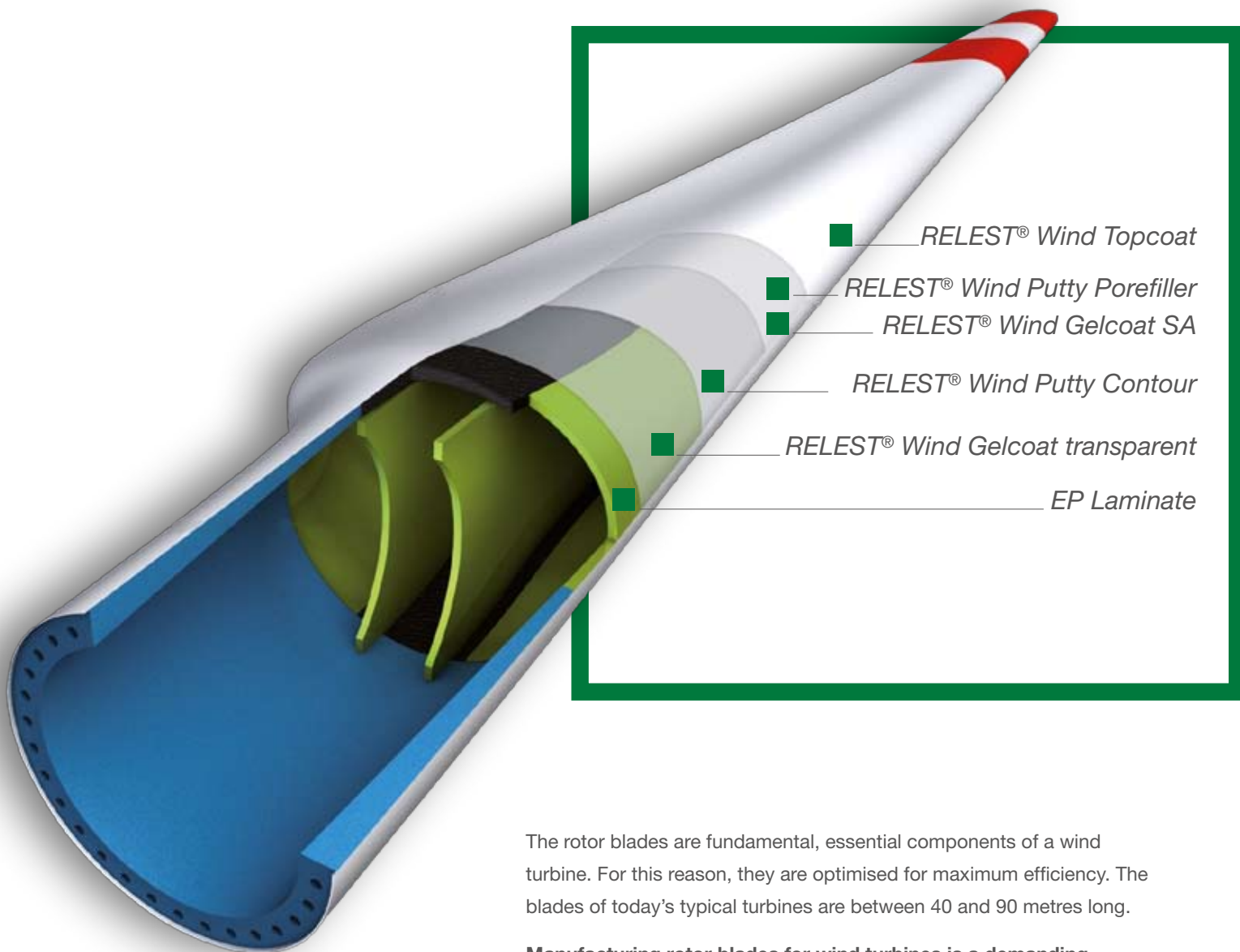
The expanding wind energy sector is an outstanding example of performance potential. Adverse weather conditions, such as wind and water, UV radiation, erosion and bending strains, place extremely high demands on the material around the clock. All components must provide long-lasting performance – this is the only way wind turbines can work efficiently and economically. In this area, BASF has offered convincing solutions for many components since the mid-1990s – we can prove this with more than 30,000 coated rotor blades.

With the global presence of BASF – own corporations in 80 countries worldwide – we can use these contacts everywhere, providing local individual support. This creates efficient value chains for coating materials in the wind energy sector. The BASF Verbund provides us with unbeatable advantages: our core processes are well-managed, and we can respond flexibly and take action independently, practically anywhere in the world.

Baxxodur®, MASTERFLOW 9500® and RELEST® are brand names of the BASF Group and registered in many countries.

■ CONSTRUCTION OF A ROTOR BLADE

HOW ROTOR BLADES DEFY THE FORCES OF NATURE



The rotor blades are fundamental, essential components of a wind turbine. For this reason, they are optimised for maximum efficiency. The blades of today's typical turbines are between 40 and 90 metres long.

Manufacturing rotor blades for wind turbines is a demanding business: the largest and most modern blades are made from bonded glass and carbon fibre mats into which epoxy resin is injected under vacuum. Composite materials on this basis have become the industry standard. BASF has developed a product range specifically for this process. The blades are built according to the sandwich construction principle and are stabilised with reinforcing spars and bars on the inside. This high-tech construction technique also provides for exceptional stability and flexibility.

The finish consists of multi-layer polyurethane-based coats, with different erosion and UV resistance depending on requirements. The coatings' excellent adhesion properties minimise the risk of stress cracking. In addition, their flexible behaviour prevents them from flaking off despite rotor tip vibrations that cause them to bend by several metres. Our products thus provide lasting protection for operating times of up to 20 years.



RANGE OF APPLICATION ■

A WIND-BASED CONCEPT GAINS MOMENTUM

Considering the central role of renewable energies, wind energy has taken on new significance. Intensive efforts are underway to boost its competitiveness with respect to other sources of energy, with turbines becoming ever bigger and more powerful. The trend is for wind energy plants to move from land (onshore) to the sea (offshore), where the wind blows more strongly and steadily, thereby generating higher energy yields.

Onshore turbines characterise the classic use of wind energy on land and have a long tradition. They have proven themselves to work efficiently and reliably worldwide. We offer individual product solutions to address any regional challenge.

The trend towards offshore plants has raised the bar for the technology: rotor diameters of more than 150 metres, blade lengths of up to 90 metres and the extreme climate on rough seas pose a challenge for construction and materials.

In addition, the importance of repowering in the wind energy sector is growing. The rapid further development of the technology and maximisation of its efficiency have made it economically feasible to replace or upgrade wind turbines even before their technical lifespan expires.

The following applies to all fields of application: the new RELEST® brand products by BASF will support the production of eco-friendly energy sustainably.

■ PRODUCT PORTFOLIO

WHATEVER YOUR PLANS

We have the solution: From gelcoat and putty to topcoat - whatever you are looking for – we have the right offer for you.
Here is our range of products:



RELEST® Wind ProcessCoat

- Solvent-free and semi-transparent 2K polyurethane gelcoat for use as in-mould gelcoat with low film thicknesses
- Significantly easier to sand than glass-fibre reinforced epoxy substrates
- Tinted hardener for mixing control
 - > Quick visual inspection of the mixing process (manual and automated application)
- Use of the new generation of UV absorbers
 - > Temporary outdoor storage of uncoated rotor blades without the risk of UV light damaging the substrate
- VOC compliant

RELEST® Wind Gelcoat transparent

- Solvent-free 2K polyurethane gelcoat for use as in-mould gelcoat
- Significantly easier to sand than glass-fibre reinforced epoxy substrates
- Transparent process coat
 - > Suitable after demoulding for checking the rotor blades produced in the vacuum-infusion process
- VOC compliant
- Large application window
 - > Offers good flow and fast curing on large surfaces
- Pore-free surface after demoulding
 - > Can be topcoated without any additional working steps

RELEST® Wind Gelcoat SA

- Solvent-free 2K polyurethane gelcoat
- Manual and automated spray application
- Cures fast and is quickly ready for recoating and sanding
- Film thicknesses of 150 - 400 µm can be achieved in one working step with optimal flow properties
- Quick visual inspection of the mixing process (manual and automated application)

RELEST® Wind Gelcoat RA

- Solvent-free 2K polyurethane gelcoat
- Film thicknesses of approx. 200 µm can be achieved in one working step with optimal flow properties
- Quick visual inspection of the mixing process



- *Very high abrasion resistance*
- *Outstanding flexibility*
- *Top level UV resistance*
- *High degree of environmental friendliness*

RELEST® Wind Putty Porefiller

- Solvent-free 2K polyurethane porefiller for filling „pinholes“ (of different sizes), visual inspection
- Compatible with all systems
- Recoatable without scuff-sanding
- VOC compliant
- In 2K cartridges for direct application of small quantities
- Quick visual inspection of the mixing process

RELEST® Wind Putty Contour

- Solvent-free, highly viscous polyurethane putty for smoothing surface and contour irregularities
- Suitable for manual (3K) and mechanical (2K) application
- Rapid curing
> Product is quickly ready for further processing and recoating
- Damages of up to 10 mm can be repaired in one work step depending on application method
- Quick visual inspection of the mixing process (manual and mechanical application)

RELEST® Wind WB Topcoat

- Matt waterborne 2K acrylic polyurethane topcoat for use as finishing coat on rotor blades
- Dries fast and is quickly ready for recoating even at high film thicknesses without risk of blistering
- Good UV and weathering resistance
- Suitable for roller and spray application
- Good coverage of sanding scratches

RELEST® Wind HS Topcoat

- Matt 2K high solids acrylic polyurethane topcoat for use as finishing coat on rotor blades
- Dries fast and is quickly ready for recoating even at high film thicknesses without risk of blistering
- Good UV and weathering resistance
- Suitable for roller and spray application
- Low VOC content (high solids content)
- Excellent erosion protection
- High film thicknesses with good flow properties in one working step

■ THE COATING PROCESS

IT ALL COMES DOWN TO THE FINISH



One thing all our customers have in common, is the drive to design a good end product in a way that is economical, ecologically sound and innovative.

Accordingly, we offer a product system that combines several different procedures and methods, so it can be adapted to individual production processes.

At present, the most widely used process is vacuum infusion.

In this process, two half-shells are charged with release agent. The shells are lined with glass fibre mats and other reinforcing materials. A plastic film is then used to seal the moulds airtight. Afterwards a vacuum pump sucks an epoxy resin and hardener mixture into the mould and into the glass fibre mats. The blades are then hardened at 70°C and the two blade halves are bonded together.

In the next step, the rotor blade can be protected from environmental factors such as moisture and light by a gelcoat. Small irregularities on the surface are smoothed with the putty. A coating that protects the edges against wear is applied, followed by application of a topcoat in the final step.

QUALITY STANDARDS ■ QUALITY IS TOP PRIORITY



- *Constantly high level of product quality*
- *Quality assurance by BASF's quality systems*
- *Guaranteed process reliability*
- *Process-oriented solutions – worldwide*



We work together with many of the most important rotor blade manufacturers on all continents. However, this also means that our products must function as reliably in the deserts of Arizona as they would at or even in the North Sea, with life cycles of up to 20 years.

To this end, the quality requirements for our products depend on many factors such as region of use, highly diverse climatic conditions, different application fields, as well as the fact that rotor blade sizes are changing. These are challenges that we face repeatedly.

Naturally, quality assurance based on recognised testing methods is a vital factor in this process, but what can be done when there are no established testing procedures? We create our own solutions.

For instance, this is how we created our “helicopter testing device” for testing the rain erosion resistance of our products. In this custom-built unit, several coated test specimens are placed on a rotating disc.

The entire unit then rotates at up to 500 kilometres an hour through a curtain of water drops – for many hours. All coatings must undergo this endurance test.

We continue to invest in new testing methods so that we can also address future market requirements promptly, with sustainable quality and authoritative innovation.

■ THE SOLUTION

AS INDIVIDUAL AS YOUR REQUIREMENTS

Wind energy plants must work efficiently – minimal idle time and maximum operating times are the objective.

The coating systems from BASF are consistently efficiency-oriented – from the very start of the production process on.

Here it all comes full circle: As a partner, we help our customers to be more successful with their products on the market – with intelligent solutions and high-quality products.

- *Solvent-borne products*
- *High solid products*
- *Water-borne products*

Reap the benefits of high-tech systems with:

- high abrasion resistance and elasticity – and thus optimal protection from sand and rain erosion, as well as stress cracking
- exceptionally long product life – product cycles of up to 20 years are achieved even under extreme conditions
- simple, flexible application – whether brushed, sprayed or using robotics
- individual solutions – you will find exactly the right product for your requirements

CONSISTENT COATING SYSTEMS

	RELEST® Wind ProcessCoat	RELEST® Wind Gelcoat transparent	RELEST® Wind Gelcoat SA	RELEST® Wind Gelcoat RA	RELEST® Wind Putty Porefiller	RELEST® Wind Putty Contour	RELEST® Wind WB Topcoat	RELEST® Wind HS Topcoat
PRECOATING SYSTEM								
In-mould process	■	■						
Repair / filling of „pinholes“					■	■		
Sealant / intermediate coat for rotor blades			■	■				
Surface finish							■	■
AUTOMATED APPLICATION								
Repair / filling of „pinholes“					■	■		
Intermediate coat			■					
Surface finish							■	■
MANUAL APPLICATION								
Repair / filling of „pinholes“					■	■		
Sealant / intermediate coat for rotor blades			■	■				
Surface finish							■	■
REPAIR								
Repair / filling of „pinholes“					■	■		
Sealant / intermediate coat for rotor blades				■				
Surface finish							■	■
PROPERTIES								
Drying	++	+	++	++	++	++	++	+
Sanding behaviour	++	++		+	++	++		
Recoatibility			++	+				
Sagging resistance	+	++	++	+	+	++	+	++
Cartridge / aerosol can	no	no	no	no	yes	yes	no	yes



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