KRAIBURG

Gummiwerk KRAIBURG GmbH & Co. KG

KRAIBURG LEP

Leading Edge Protection

KRAIBURG LEP – Leading Edge Protection

The long-term erosion protection for wind turbine rotor blades

An increasing amount of energy is generated by wind turbines. The efficient use of the natural force of wind using innovative technologies and systems is an exciting challenge for manufacturers, as well as for servicing and maintenance companies.

The global targets for reducing CO2 emissions can only be achieved using green energy. Wind energy plays a key role here by using wind turbines. It now generates the greatest share of renewable energies and continues to grow constantly.

At Gummiwerk KRAIBURG, we are committed to sustainability to develop social and ecological solutions which provide an answer to tomorrow's global challenges.

The use of elastomers as a high-tech material has an important role. With KRAIBURG LEP, we offer a product which serves demanding applications and meets the challenges of an efficient production and application process for rotor blades.
It has shown that KRAIBURG's elastomers in combination with ultra high molecular PE provide an excellent protection of the leading edges of wind turbines against erosion damage.

KRAIBURG LEP is a quality product which was developed over recent years and tailored to the interests of an innovative, highly technical industry:

Our product is characterised by long-term erosion protection of the blades leading edges while at the same time offering UV protection. The erosion protection film distinguishes itself by easy use and handling during application. The long-term reliability with a high dynamic durability results in low maintenance and repair costs for the operator.

As our material is especially suitable for use in extreme conditions, our customers benefit from KRAIBURG LEP in both onshore and offshore sectors.

Sector and area of use:
Wind power generation
Onshore and offshore

Extreme challenges

Increasing the service life of wind turbines

Offshore wind energy is becoming more and more established in the energy mix. Strong and consistently blowing winds without geographical obstacles make offshore plants interesting. Over the course of recent years, the plants have not just become more efficient, but also bigger and bigger. Longer rotor blades now achieve greater blade tip speeds.
In particular on the high seas, the rotor blades are exposed to extreme weather conditions. Rough winds and the interaction between water and salt affect these heavily. Flaws occur, particularly at the tips, and the surface erodes.

KRAIBURG LEP prevents the premature damage of the original surface quality of the rotor blades for highly stressed blade tips, thanks to its especially good erosion resistance.

Source: blade care GmbH

KRAIBURG LEP protects the surface

Tried and tested system

Pioneers in the wind energy sector have been using KRAIBURG LEP successfully for a few years now. While the first generation already showed excellent wear protection, the further development of the erosion protection is now focused on more specific areas. Today, we can rely on a tried and tested system which has proven itself many times.

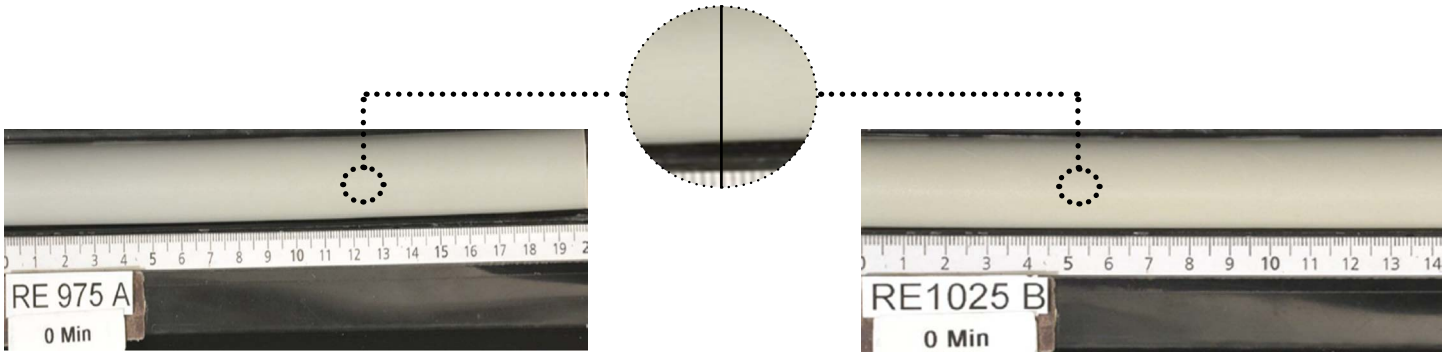
Fatigue test

Fatigue behavior of KRAIBURG LEP was demonstrated in a fatigue test. The fatigue test was carried out in both lead and lag directions, each with two million cycles. This test is to simulate a period of 20 years.
KRAIBURG LEP impressed in this test thanks to its solid endurance/resistance. After the test, the bond between KRAIBURG LEP and the rotor blade was still excellent and showed no defects at all.

Rain erosion test after 2000 hours of UV exposure

Rain erosion represents one of the greatest stresses for rotor blades. A simulation of rain erosion was carried out in various extensive and independent series of tests. Here, the layers of KRAIBURG LEP were horizontally sliced. It was shown that the surface of the KRAIBURG LEP film was only slightly eroded or roughened from the UV exposure and rain erosion. Common films failed in the same conditions, their surfaces were damaged during the test and removed in little pieces.

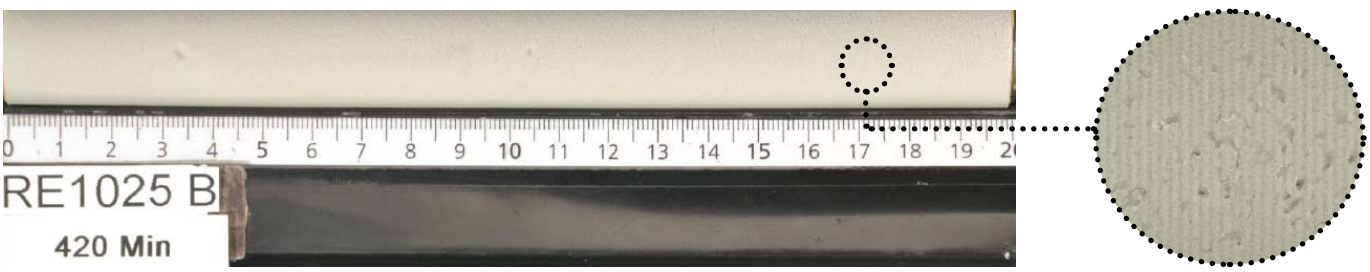
In a direct comparison to other coating films, KAIBURG LEP lasts up to 28 times longer during UV exposure. The condition after the 2000 hour test compared to the starting situation allows us to conclude long-term blade edge protection, which is also confirmed in the field tests.



Starting condition

Condition after 2000 hours of UV exposure

Result: Almost no difference in colour identified from the starting material RE975 A with almost the same mechanical output values as material RE1025 B.



Condition after 2000 hours of UV exposure and the 7-hour rain erosion test

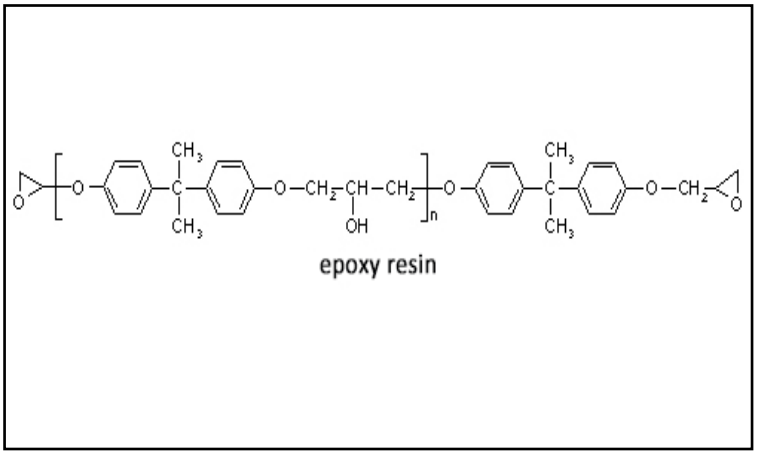
Result: KRAIBURG LEP demonstrated the same level of performance. The surface is only slightly roughened.

Applications

KRAIBURG LEP can easily be applied to the rotor blade as a two-layer system. The application is easy in both a controlled production environment and in the field under servicing conditions. There are two bonding options available for this.

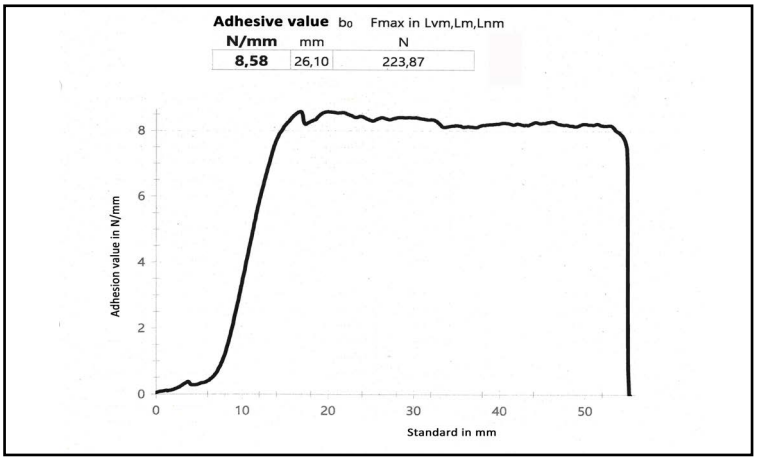
Application with resin

KRAIBURG LEP can be integrated directly into the infusion process as the resin can have a covalent bond with the elastomer. As an elastomer specialist, KRAIBURG has developed a special elastomer coat which bonds with the infusion resin during the curing process at temperatures as low as room temperature. This bond also exhibited no signs of wear after a three-month test phase.



Application with adhesive

If the surface has been damaged by external influences, it is also possible to replace KRAIBURG LEP partially. Here, KRAIBURG recommends the use of a corresponding adhesive which was tested together with the adhesive manufacturer.



Peel test according to DIN ISO 813

ADVANTAGES of using KRAIBURG LEP

- High impact resistance: Protection of the underlying layer of the laminate structure from impacting water drops or other particles
- Possibility of direct integration through resin infusion during rotor blade manufacture – without additional bonding agents
- Possibility of subsequent application using a suitable adhesive (e.g. when servicing the rotor blades)
- Proven better drainage of water droplets due to low surface tension
- Excellent UV resistance

Impact resistance

Films which are available on the market allow the energy of the impacting rain to pass through on to the laminate unimpeded. Extensive tests using X-ray computer tomography show that damage to the fibre composite structure at the point of impact is significantly diminished by using KRAIBURG LEP.

High dynamic durability and lifespan, UV resistance, wear

Partial repair

When developing KRAIBURG LEP, the focus was on practical requirements. Here, the option of partial repairs (splicing) was considered. In this context, a repair point with impact at an angle of 45° and 90° was tested. A ten-hour rain erosion simulation revealed no difference to the undamaged film. This confirms the high durability of KRAIBURG LEP.

Servicing costs

Regular maintenance and servicing play a crucial role in the cycle of a wind turbine. A damaged surface leads to a lower performance of the rotor blades and results in high repair costs. When KRAIBURG LEP is used, the possibility of partial repairs reduce service and repair costs.

Lower servicing and repair costs

Technical data

Features	Standard	Test values
Film thickness (mm)		1.0
Film width (mm)		120.0
Film weight (g/m^2)		990.0
Tensile strength (Mpa)	DIN 53504	22.5
Elongation at break (%)	DIN 53504	399.0
Peel adhesion (N/mm)	ISO 813	9.0
Peel adhesion cataplasm test (N/mm)	5 cycles: 12h @ 70°C + 12h @ -25°C 100% relative air humidity, ISO 813	8.8
Rain erosion test (h)	ASTM G73, V_{tip}max: 157 m/s Rain density: 450 mm/h Size of drops: 2–3 mm	> 10
Splicing: 45° and 90° rain erosion test (h)	ASTM G73, V_{tip}max: 157 m/s Rain density: 450 mm/h Size of drops: 2–3 mm	> 10
2000 h UV exposure	ASTM G154-16 ASTME13-15e loop	Very good
Rain erosion test after 2000 h UV exposure	ASTM G73, V_{tip}max: 157 m/s Rain density: 450 mm/h Size of drops: 2–3 mm	>7
Fatigue test	Undulation in lead and lag directions cycle: 2x10^6	Adhesion: good Surface: no flaws Bond between film and filler: no formation of flaws

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A product from:

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