REWITEC™
Part of Croda International Plc

Presented by

Stefan Bill

Geschäftsführer,
REWITEC GmbH

12. November 2021

Höhere Zuverlässigkeit und längere Lebensdauer für Windkraftanlagen

Forum 4, Technik & Innovationen

Smart science to improve lives™

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Agenda

- Company and products
- Technology
- Scientific tests
- Examples of application
- Gearbox and bearing lifetime calculation
- Conclusion

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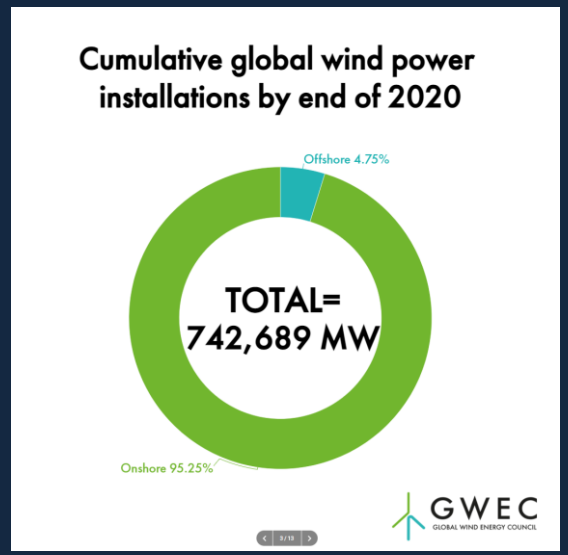
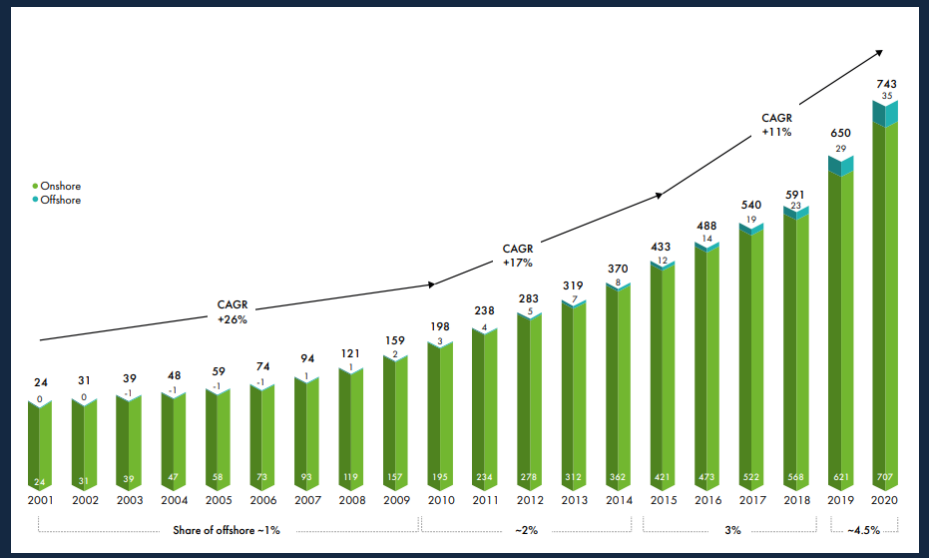
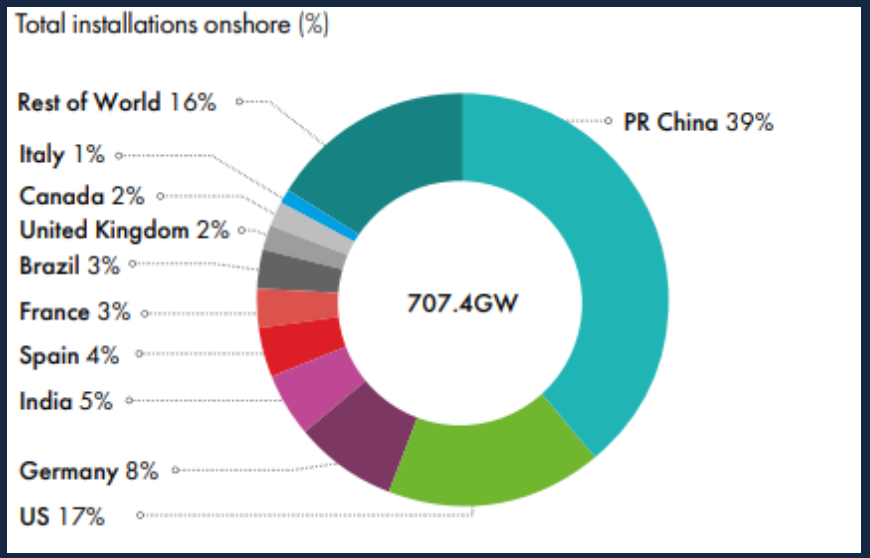
Global Wind Market

- Historic development in 2020, 53% (93GW) growth of new installations compared to 2020







- 743 GW installed power means:
  - About 370.000 installed wind turbines globally (2 MW/turbine)
- Absolute growth from 2001 to 2020
  - About 150,000,000 litres of oil
  - About 20,000,000 kg of grease
  - Replacement every 5-10 years
- Total installations by country without 35,3 GW offshore

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The challenges of unscheduled maintenance costs remain

- Calculation mistakes, environmental conditions, missing or even wrong maintenance can cause unforeseen breakdowns.

Maintenance represents **25 %** of the total wind turbine cost over its lifetime

Unscheduled maintenance represents **30 - 60 %** of total maintenance costs

Up to **14 days** needed to repair a gearbox or bearings - more than any other component

Average cost to repair a gearbox failure is **380,000 $**

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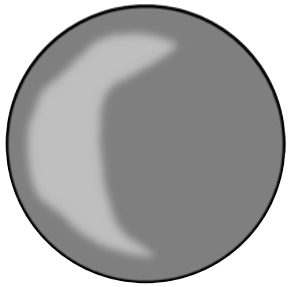
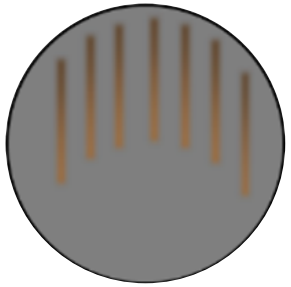
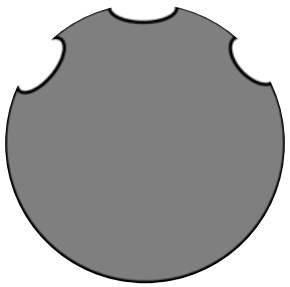
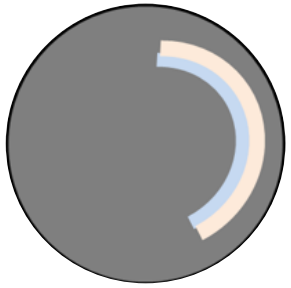
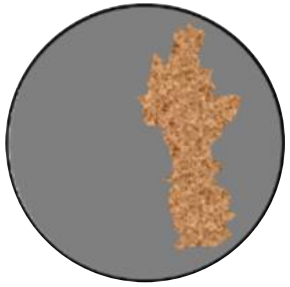
Typical damage to gears & bearings

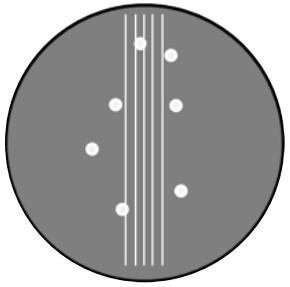

Micropitting/ Grey staining

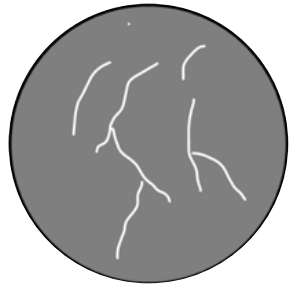

Fretting corrosion

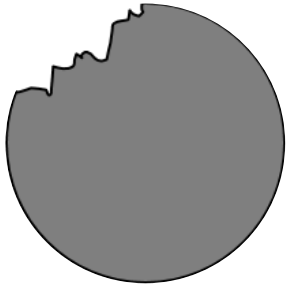

False brinelling

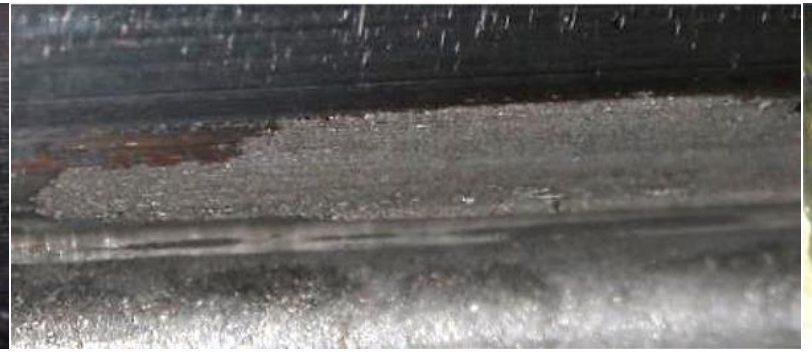

Smearing and scuffing


Chemical corrosion


Electric damage


White etching areas/cracks


Macropitting



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Company and products

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Key facts about REWITEC

- Founded in 2003
- Close cooperation with universities and research institutes
- Supported by the German Government
- Patents in Europe, China, USA
- Acquisition by CRODA in 2019

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JUSTUS-LIEBIG-UNIVERSITÄT GIESSEN

Supported by:
Federal Ministry for Economic Affairs and Energy

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Target markets

- Wind energy
  - Onshore
  - Offshore

- Industry
  - Steel
  - Cement
  - Mining
  - Oil, Gas

- Marine
  - Shipping
  - Barges
  - Yachts
  - Submarine

- Automotive
  - Consumer
  - OEM
  - Motorcycles
  - Racing
  - Classic cars

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Examples of application

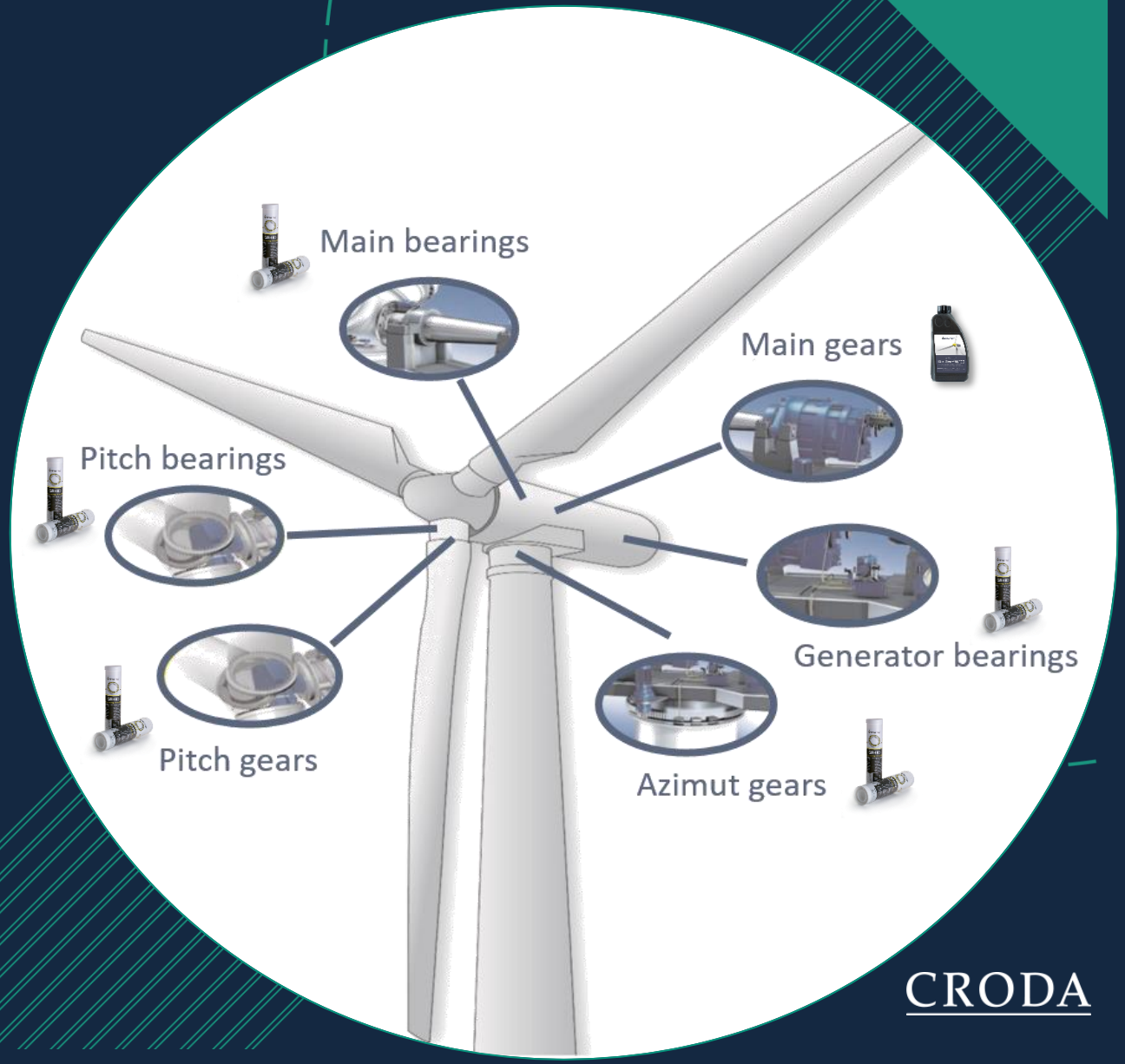
⇉ Over 3,000 successfully treated wind turbines globally

DuraGear™

Gears

GR400

Bearings



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REWITEC technology

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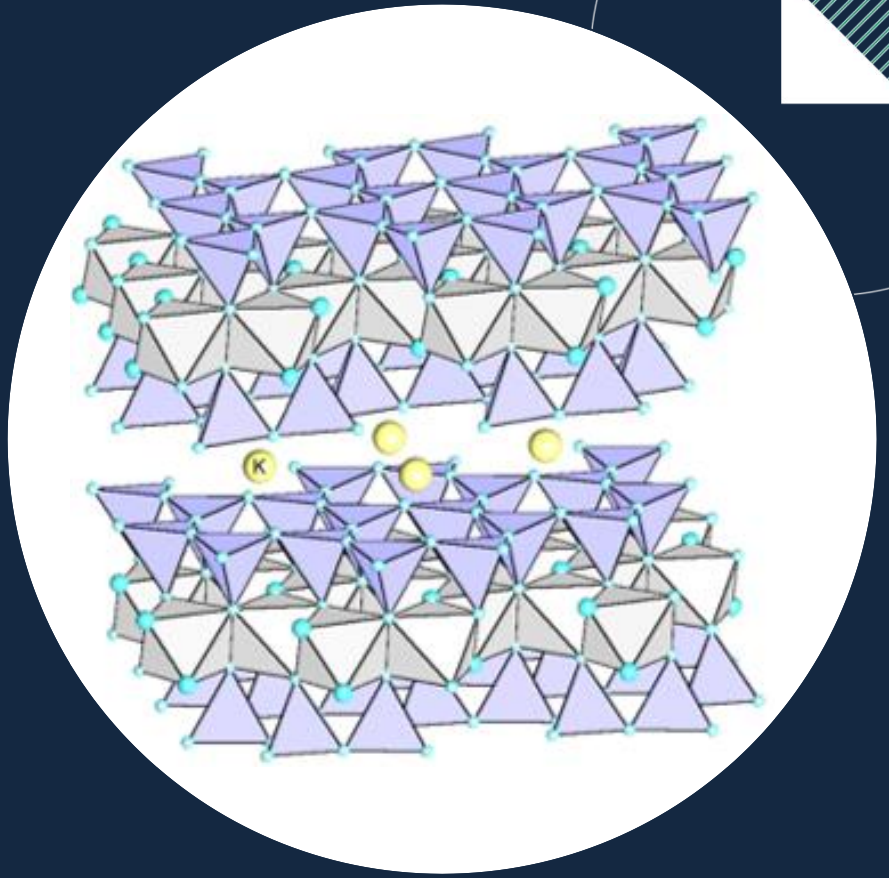
Phyllosilicate based particle additive

- Platelet-shaped particles with layered crystal structure
  - Si-O and Al-O based layers
  - Strong *covalent* bonds within the layer
  - Weak *van der Waals* interaction between the layers

- Easy shearing between the layers
  - **Friction reduction**

- Big specific area with high adsorption ability
  - covering the surface, filling the holes
    - **Protective, repairing and smoothing effect**

- Particle size d90 = 4 µm
- Soft material: Mohs Hardness Scale 2.5 (like fingernail!)



Our scientific paper:

- ”Tribological properties of a phyllosilicate based microparticle oil additive”
- Chizhik et al., Wear 426–427 (2019) 835–844

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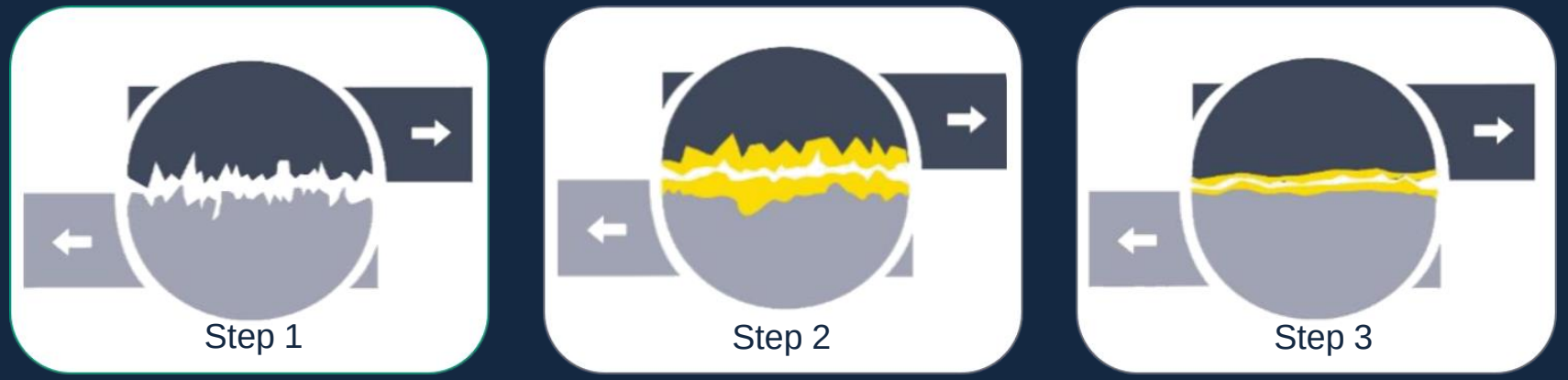
How REWITEC works



Significant reduction of friction, wear, roughness and temperature

- **Advantages:**
  - Compatibility to all common lubricants
  - Temperature independent
  - No chemical interactions with other lubricant parts
  - Low dosage

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Scientific tests

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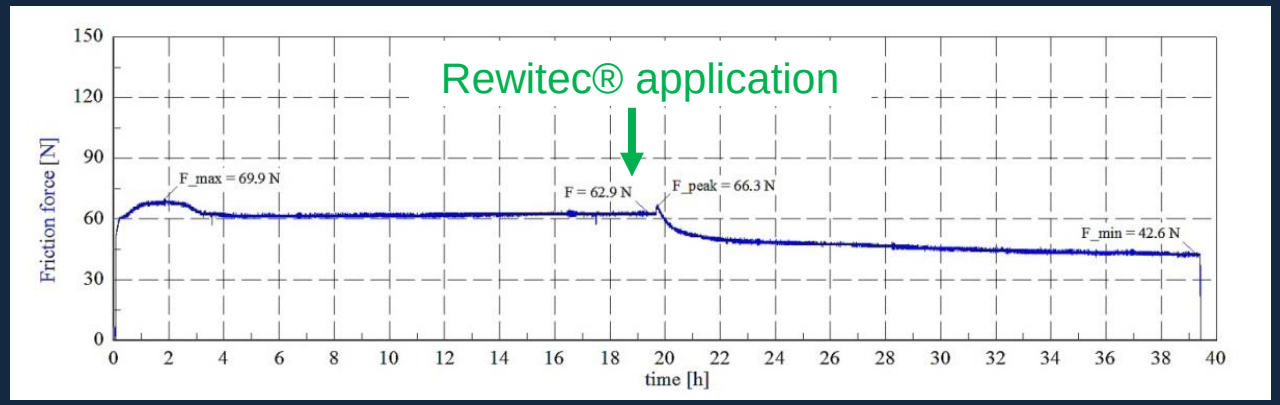
2-Disc assembly rolling wear test – gear oils

- Stress value: 1 GPa (normal force 2150 N)
- Rotating speed: 424 rpm / 339 rpm, slip 20 %
- Test-duration: 39,3 h
- Temperature: oil inlet temperature 60 °C
- Friction coefficient: μ=normal force/friction force



Castrol Optigear Synthetic X320

Oil	Friction reduction	Roughness reduction
Castrol Optigear Synthetic X320	33 %	41 %
Mobilgear SHC XMP 320	35 %	44 %
Klübersynth GEM 4-320N	40 %	54 %
Fuchs Unisyn CLP 320	36 %	50 %
Amsoil PTN 320	46 %	18 %
Shell Omala S4 GX 320	42 %	25 %
Klüberbio EG 2-150	55 %	40 %
Fuchs Pentosin EG FFL-7A	41 %	35 %
Automotive racing gear oil	55 %	40 %

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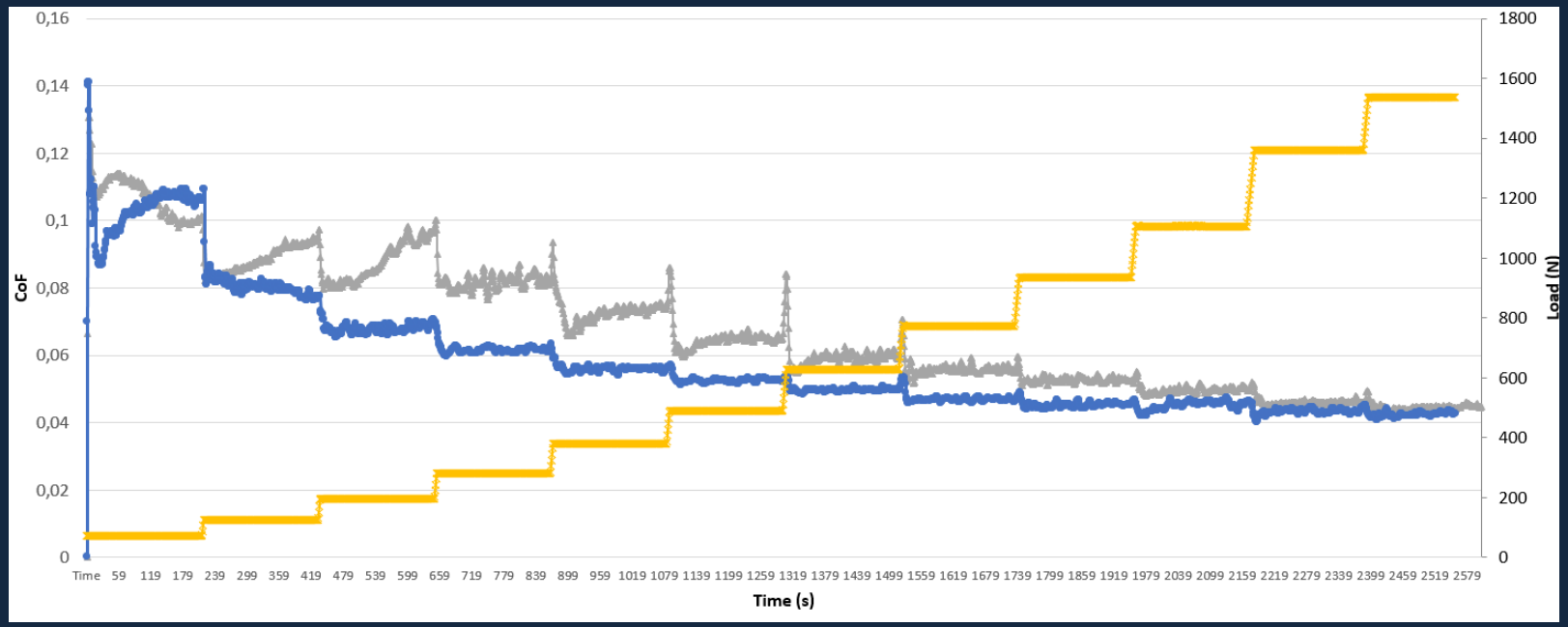
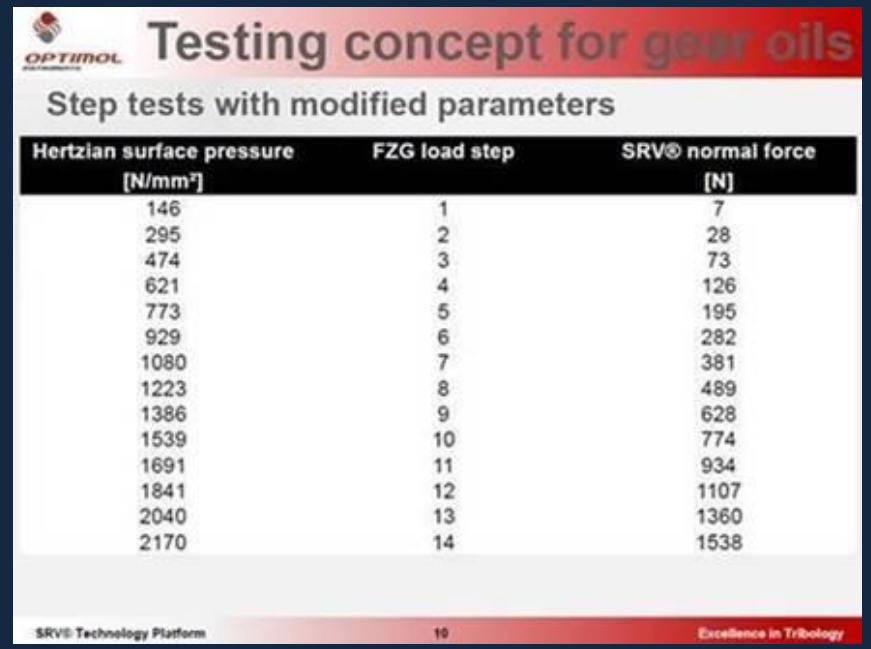
SRV – FZG simulation

Temperature: 98°C
Frequency: 50 Hz
Stroke Length : 4 mm





- Castrol X320
- Castrol X320 + Rewitec
- Load

⇉ 12 % wear reduction with REWITEC

⇉ Up to 30 % friction reduction with REWITEC

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FE-8 roller bearing test

- Speed: 7.5 rpm
- Test duration: 80 h
- Temperature: 80°C
- Load: 80 kN

Advantages with REWITEC:

- 17 % less wear
- Smoother surface
- Better load distribution
- Protection for rolling elements and rings

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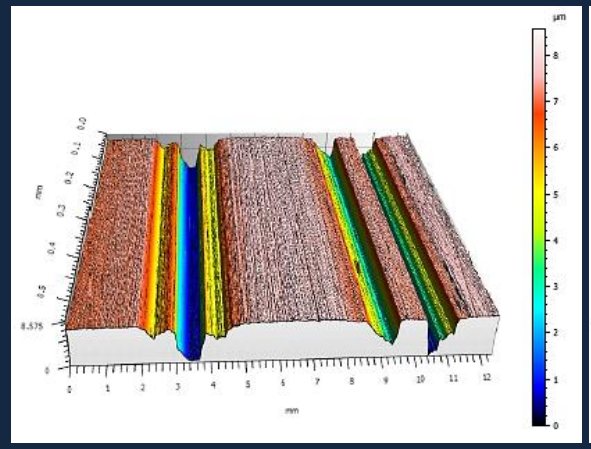
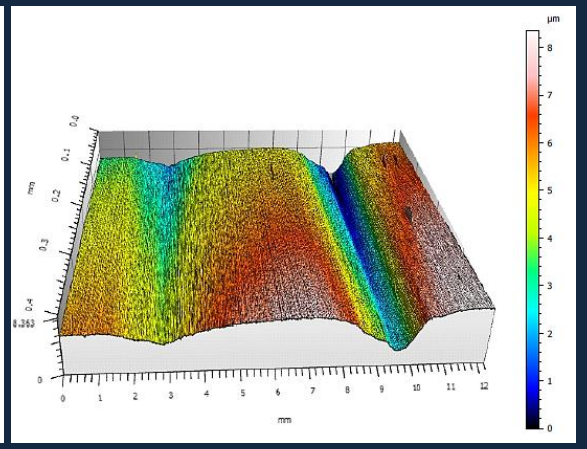


Castrol X320 **without REWITEC®**



Castrol X320 **with REWITEC®**

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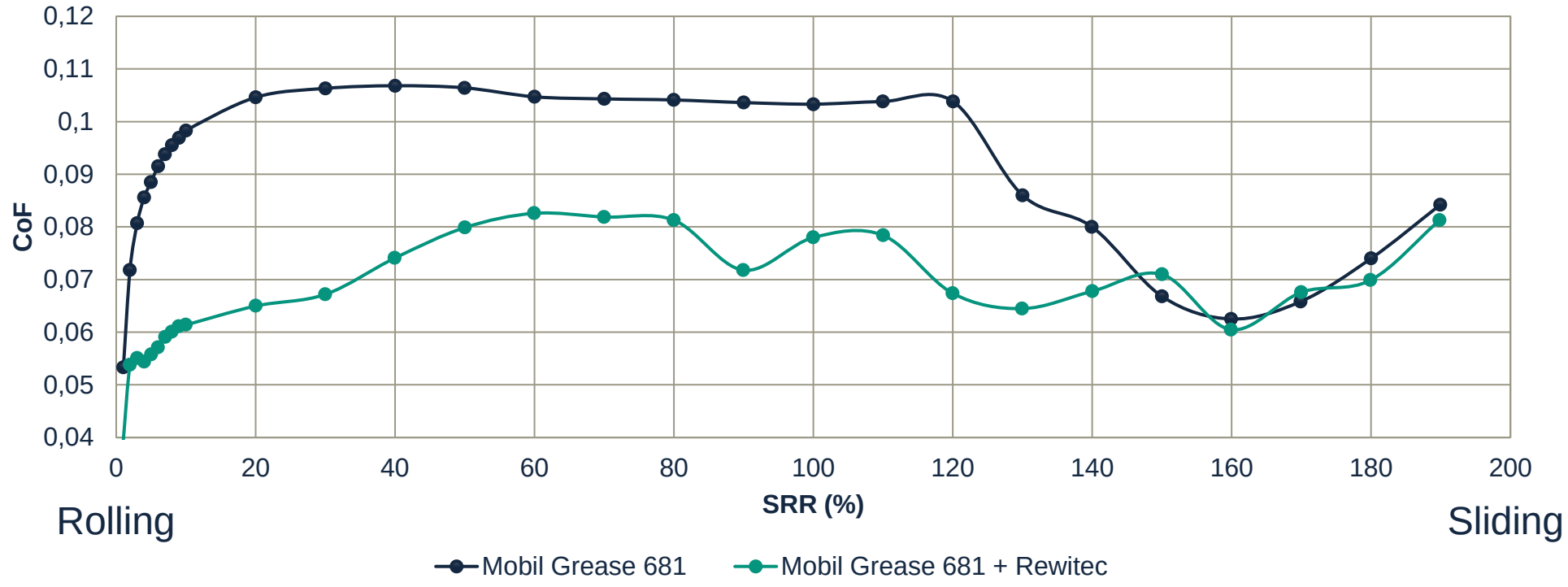
MTM test bench - grease test

- Load: 70 N
- Temperature: 23°C
- Time: 172 s

700 mm/s



⇉ Up to 38 % friction reduction with Rewitec

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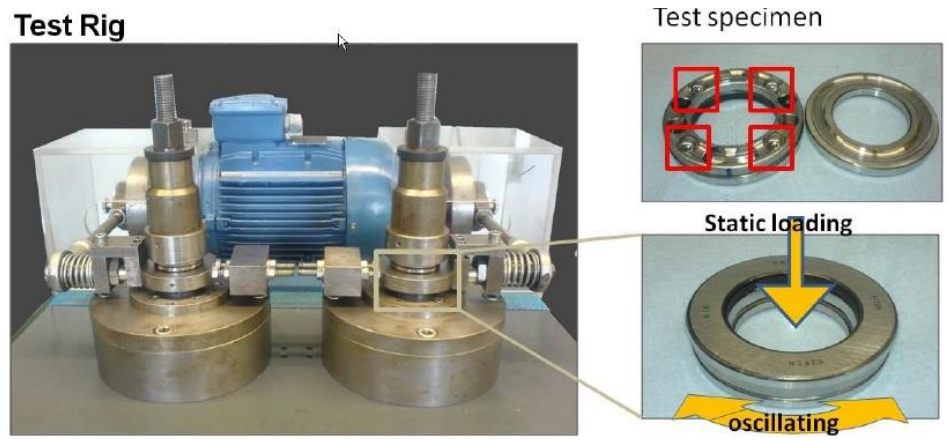
False-Brinelling test – For pitch bearing evaluation

- Frequency: 25 Hz
- Oszillation angle: +/- 0.5° -> +/- 3.0°
- Axial load: 3 kN to 4 balls (750 N per ball)
- Temperature: room temperature
- Test bearing: ARKL Type 51206 with 4 rolling elements

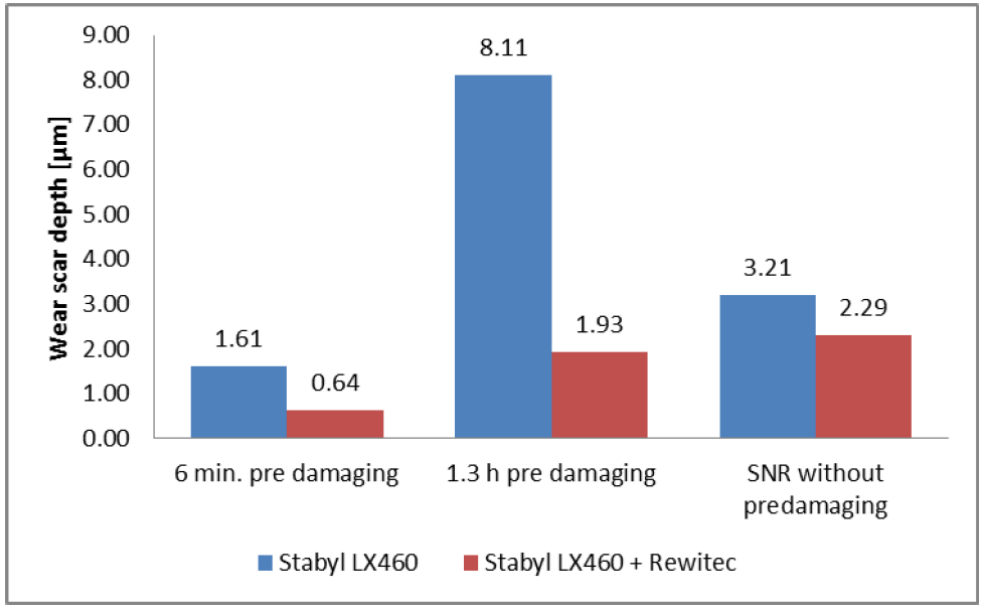


Fuchs LX460

pre-damaging
(1.3 h; +/- 0.5°)

Fuchs LX460 Fuchs LX460 + **REWITEC™**

Run after the damaging
(3 h; +/- 3°)



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Examples of application

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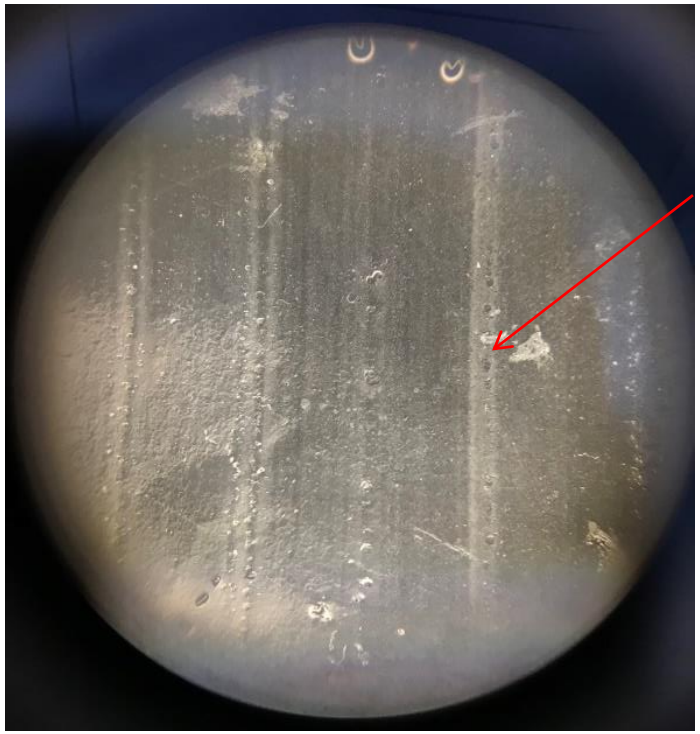
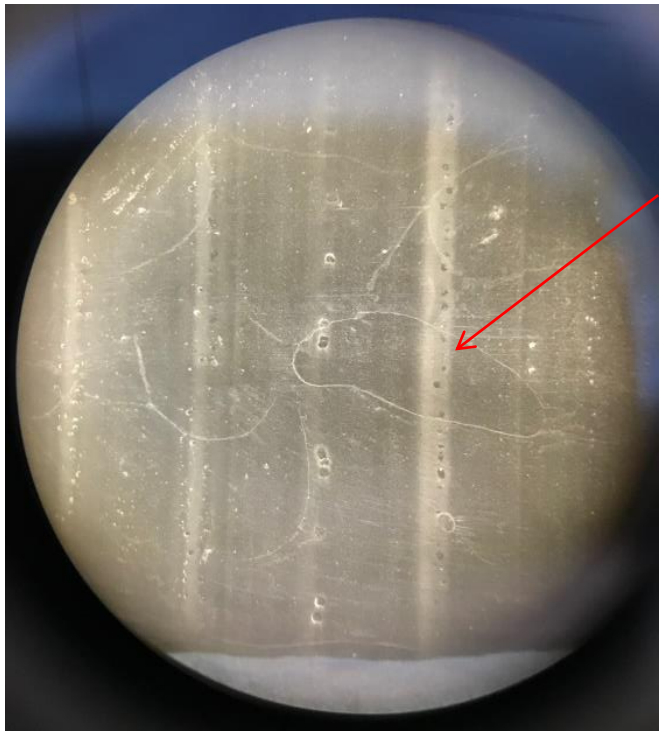
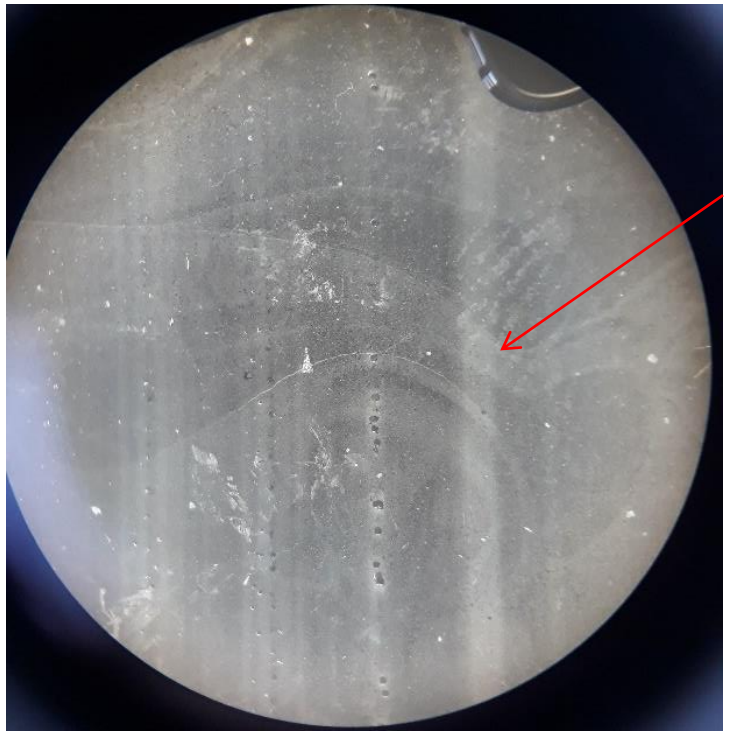
Coating and analysis of a main bearing (outer ring) GE 1.5 wind turbine



⇉ Picture: Before wind turbine was treated with REWITEC™



⇉ Picture: 5 months after wind turbine was treated with REWITEC™



⇉ Picture: 12 months after wind turbine was treated with REWITEC™

→ Red arrow shows the same right track on the surface imprint

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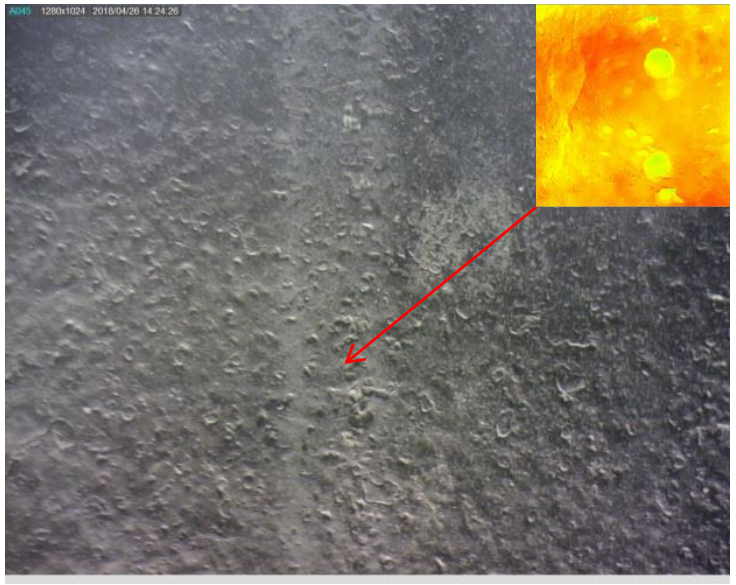
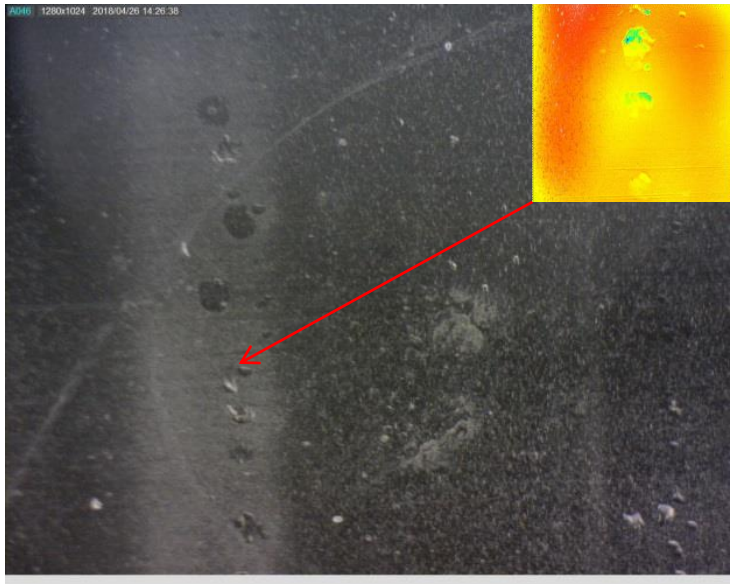
Coating and analysis of a main bearing (outer ring) GE 1.5 wind turbine

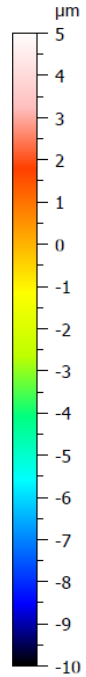


- Picture: Before wind turbine was treated with REWITEC™
- Ra = 0,556 µm (within the track)



- Picture: 5 months after wind turbine was treated with REWITEC™
- Ra = 0,403 µm (within the track)

- Picture: 12 months after wind turbine was treated with REWITEC™
- Ra = 0,225 µm (within the track)



→ Red arrow shows the same right track on the surface imprint

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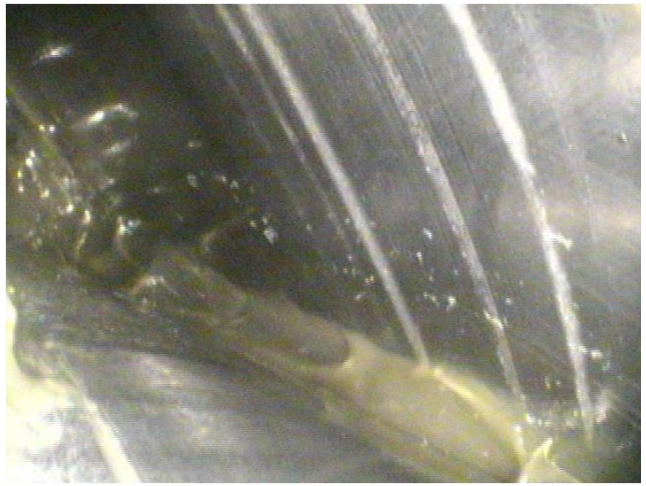
Main bearing (outer race) GE 1.5 wind turbine



⇉ **Before** wind turbine was treated with REWITEC™

⇉ 6 months **after** wind turbine was treated with REWITEC™

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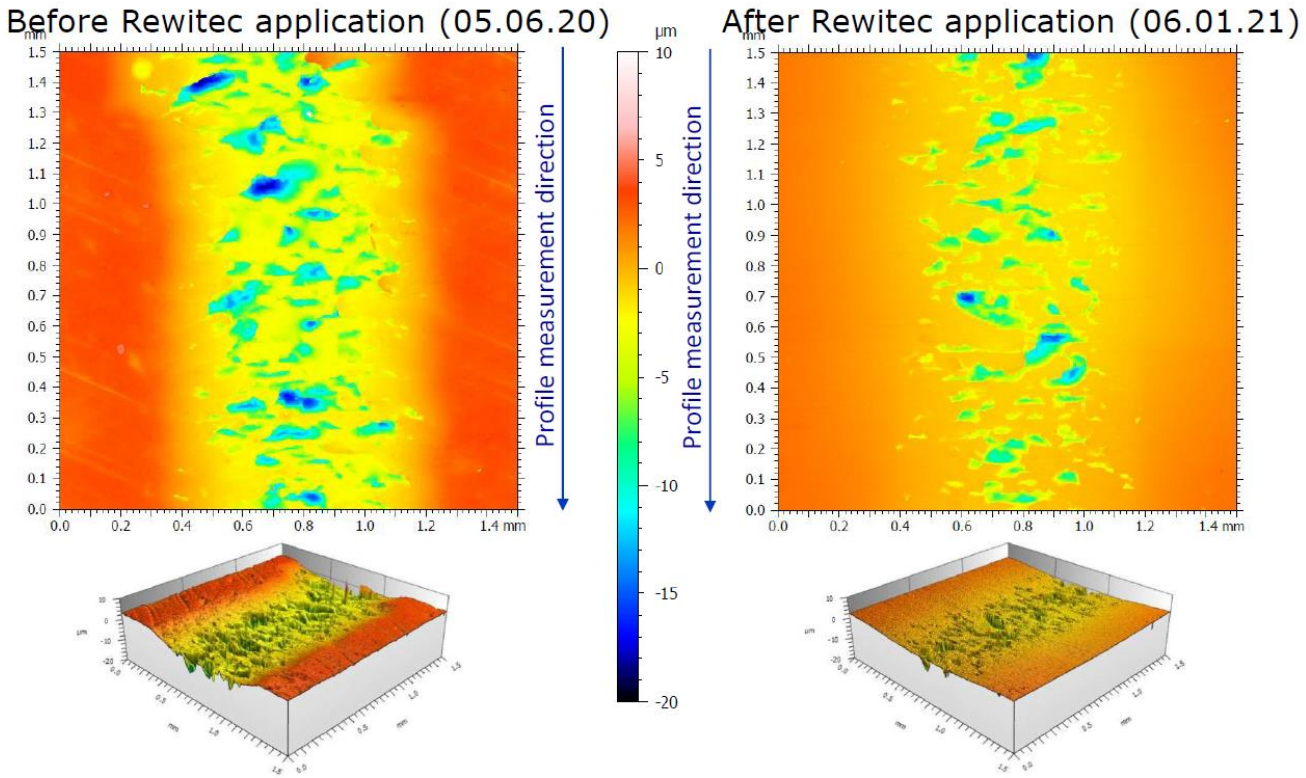
Coating and analysis of a main bearing GE 1.5 wind turbine

Roughness	Before	After	Difference
S_a	3.00 µm	1.47 µm	- 51 %
S_z	56.7 µm	19.8 µm	- 65 %
R_a	0.789 µm	0.600 µm	- 24 %
R_z	4.10 µm	3.38 µm	- 18 %



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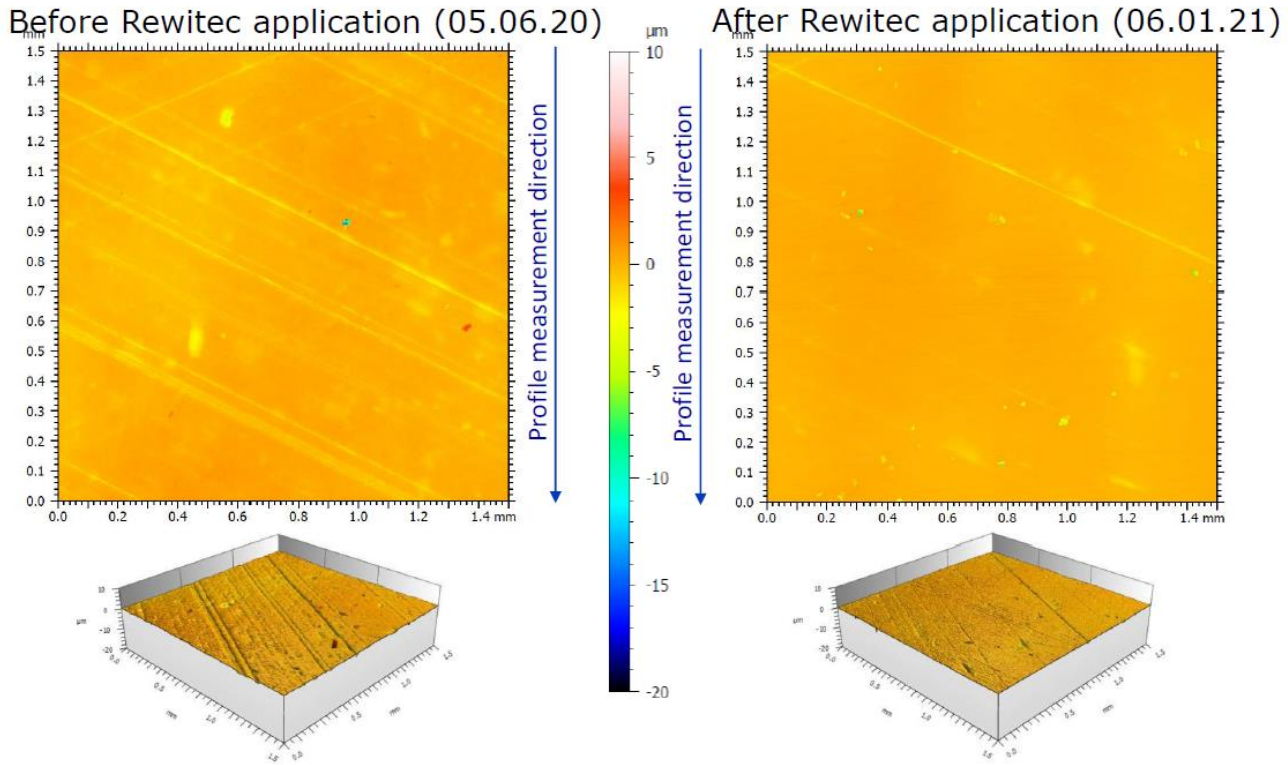
Coating and analysis of a main bearing GE 1.5 wind turbine

Roughness	Before	After	Difference
S_a	0.266 µm	0.159 µm	- 40 %
S_z	22.2 µm	11.6 µm	- 48 %
R_a	0.145 µm	0.064 µm	- 56 %
R_z	1.31 µm	0.767 µm	- 41 %



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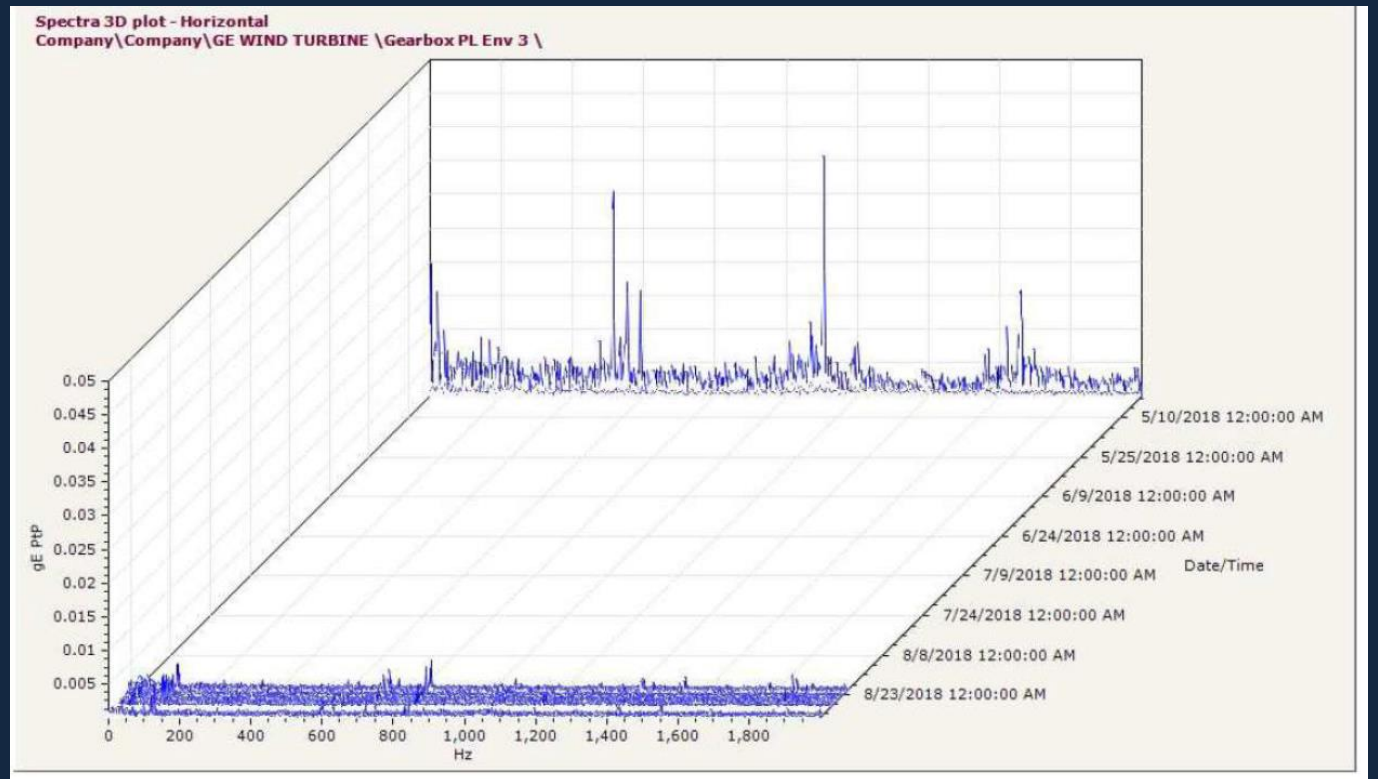
Wind turbine 1.5 MW
GE 1.5 Planetary Bearing



PLANETARY BEARING MEASUREMENT PRE- TREATMENT IS IN BACK, POST IS IN THE FOREGROUND

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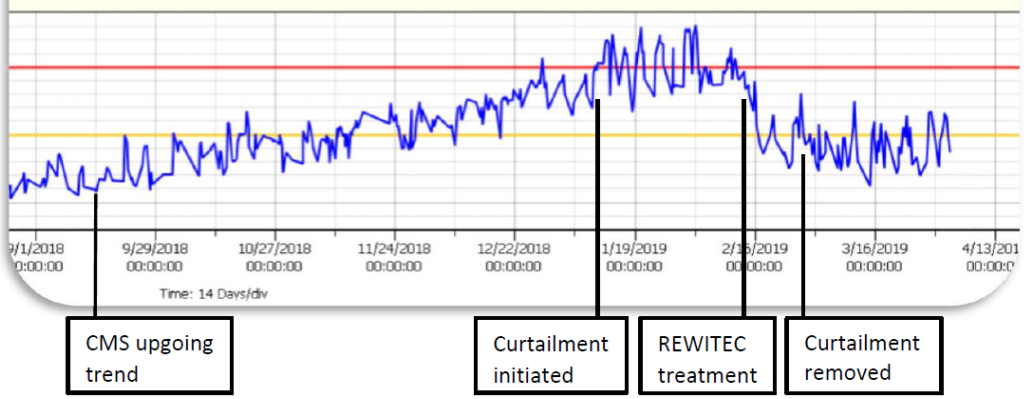
Wind turbine 1.5 MW
GE 1.5



⇉ Before REWITEC™ treatment

⇉ After REWITEC™ treatment

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Sentient Science

- Lifetime calculation model by using REWITEC™

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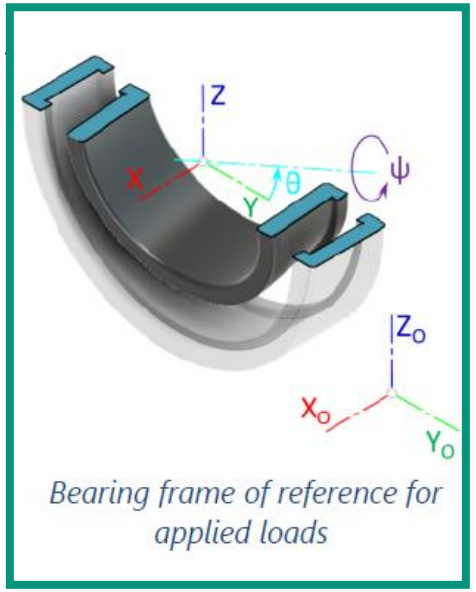
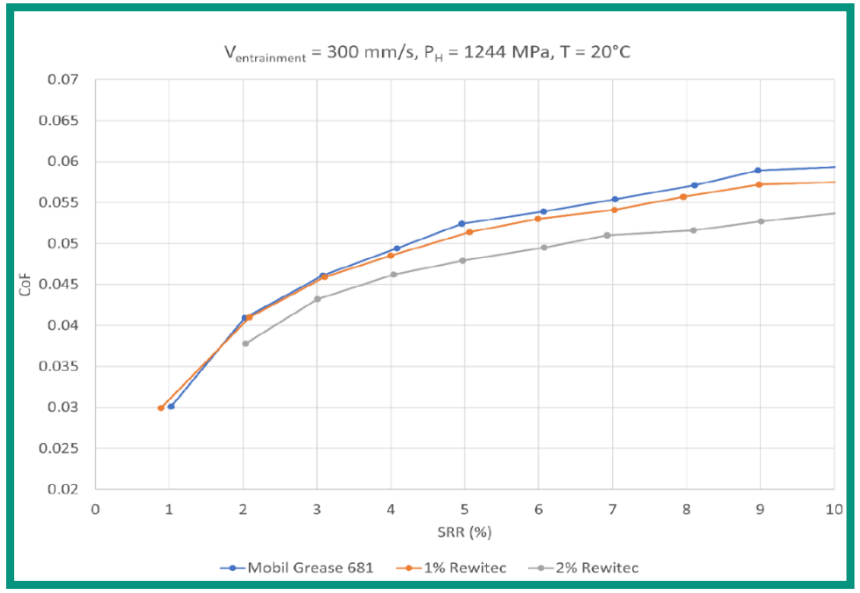
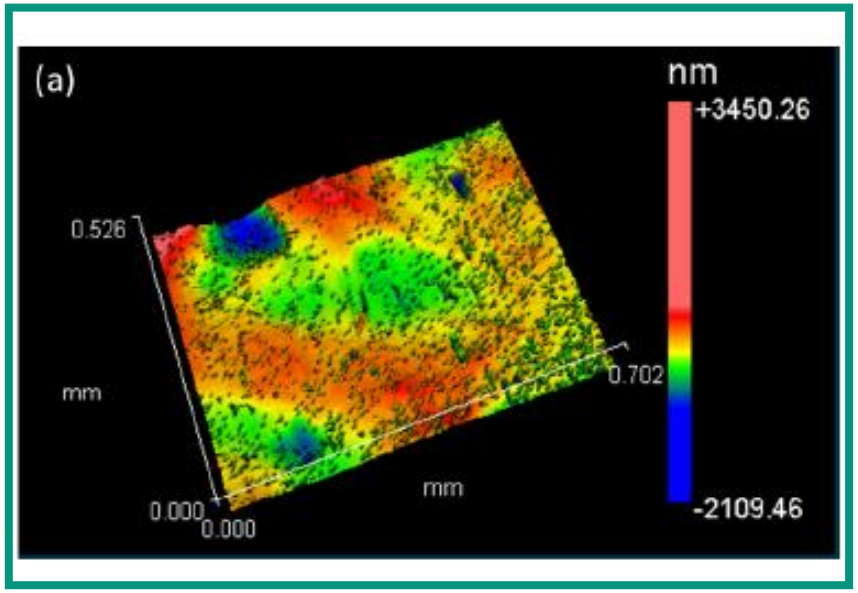
Sentient Science Lifetime Calculation

⇉ Calculation based on bearing geometry, friction coefficient and surface topography:



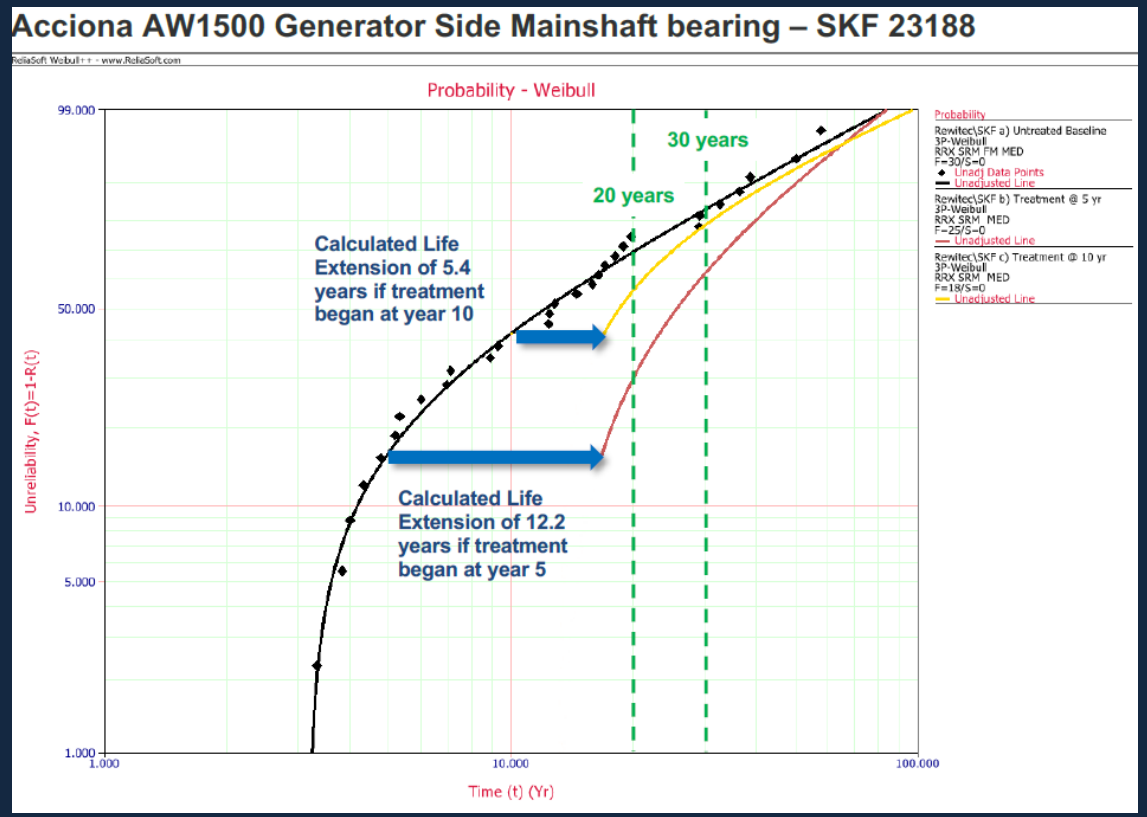
Bearing frame of reference for applied loads





Sentient Science Lifetime calculation

- Mainshaft Bearing Life Extension by REWITEC™ GR400 Grease using Sentient Science' DigitalClone®



- Results:
  - Significant reduction in the probability of failure of a main bearing by REWITEC™
  - Less roughness
  - Less friction
  - More even load distribution
  - Lower local pressure/ stress
- The earlier the application, the greater the effect

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Conclusion

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Conclusion

- Less surface roughness, friction and temperature in the drive train system means:
  - Less stress and wear for the gearbox and bearings
  - Less stress for the lubricants
  - Repairing and protection effect
  - Higher efficiency
  - Higher reliability and availability, no downtime
  - Significant lifetime improvement
  - Cost savings, higher earnings

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Our services

Component surface imprinting

Component damage analysis and reporting

Technical advice, including up-tower inspections

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Wir freuen uns auf Ihren Besuch an unsrem **Stand 113**!

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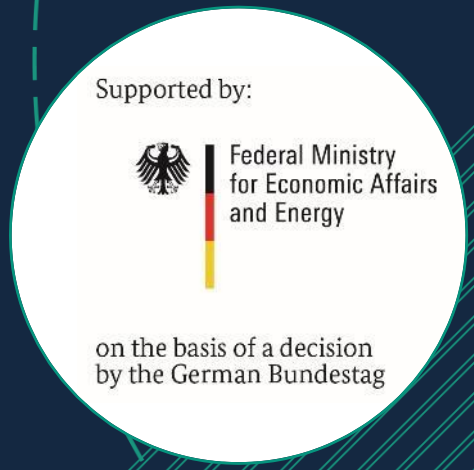
If you need more support – Please contact us.



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