Application report – 42/Sinovel BRAZIL

Sinovel SL 1500 wind trurbine gearbox treatment

Report Date:	22.02.2018
Sector:	Wind power industry
Client/Partner:	Statkraft Energias Renováveis 88015-100-000 Florianópolis SC Brazil
Contractor:	REWITEC GmbH Dr.-Hans-Wilhelmi-Weg 1 35633 Lahnau - Germany Tel. +49 (0)6441 44599-0 Fax +49 (0)6441 44599-25
Responsible:	E. Michael König
Order date:	08.11.2017 and 09.0.1.2018
Wind farm location:	Barra dos Coqueiros SE
Wind farm:	Barra dos Coqueiros
Wind turbine type:	Sinovel SL 1500
Serial Nr.:	BC-03
Project tasks:	Surface improvement of gearbox gears and bearings. Application with REWITEC® DuraGear® W100 Gearbox Surface Protection, as well as detecting the state of the gear surfaces with the REWITEC®-Replica Set (Surface imprints).
Tasks:	➢ Change of the main filter ➢ Temporary switch off of the by-pass filter ➢ Surface treatment with REWITEC® DuraGear® W100

Content

1. Aim of application

The gearbox shows mayor damages on bearings and tooth flanks. The purpose of an application with REWITEC® DuraGear® W100 is, to extend the life of the gearbox as much as possible. The analysis will be documented with the aid of surface imprints before and after the application of the selected tooth flank. The tooth flank is marked with an oil-resistant paint, so the same spot could be found later for the second inspection after the treatment. The measurement of the electrical resistance is further prove of the surface coating with silicon.

1.1 Background

The main gearbox in wind turbines converts the speed generated by the rotor system into the correct speed the generator requires. Since the gears are exposed to very heavy and varying loads, the parts are subject to strong material stress.

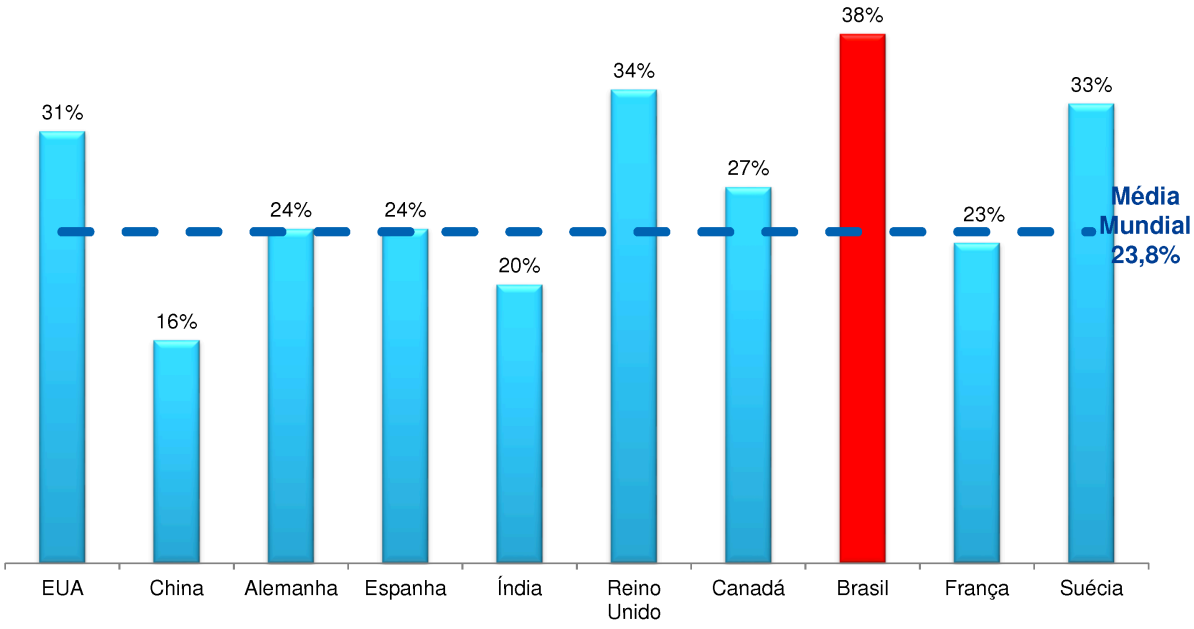
Almost all Brazilian Wind farms are located on the coast, and therefore subject to heavy pollution with sand, salt and high humidity. With a wind efficiency level of 38%, Brazil is 60% above the world average.

Image 1: Wind turbine tower BC-03 at the Barra dos Coqueiros SE Wind farm

Fator de Capacidade – 2015 (Diferencial Brasileiro)

ABEEólica
Associação Brasileira de Energia Eólica

Brazil's Wind capacity factor, the highest in the world (60% over average)



Fonte: MME/ABEEólica

Graphic 1: wind capacity factor © ABEOLICA

1.2 Tasks

Task	Name	Date
Filter change	Jhonatan Dias Costa (New Wind)	08.11.2017
By-pass filter switcht off	Nenhum instalado	
Imprint tooth flank	Jhonatan Dias Costa (New Wind) Juan Alonso Urra Peralta (New Wind)	08.11.2017 09.01.2018
Accompanied by	Roberto (Statkraft technician)	08.11.2017 09.01.2018

Report

The data obtained under this contract customer and Wind Turbine-specific information will only be used by the contractor project-related and not shared with third parties. The use of data for internal and statistical analysis, is expressly reserved by the contractor. All audit observations are exclusively found and recognizable in its condition at the time of examination.

2. Technical data

Technical data	Information
Rated capacity	1.500 kW
Hub height	100 m
Rotor diameter	82 m
Date of commissioning	2012
Oil type	Mobilgear SHC XMP 320
Oil volume	approximately 500 l

Technical information gear box

Component	Type	Serial number	Commission date
Gearbox	DHI-DCW	92603	2017

Image 2: name plate of BC-03gearbox

Image 3: illustrative gearbox image

3. Application

The selected gear of the transmission was observed on 18.11.2017, by a service technician on site. At the gear, two tooth flanks were selected and labeled with oil resistant paint.

Image 4: REWITEC® W100 application on 08.11.2017

Image 5: Surface imprints of a tooth flank of the LSIS were taken on 08.11.2017

Image 6: Surface imprints of a tooth flank of the HSS were taken on 08.11.2017

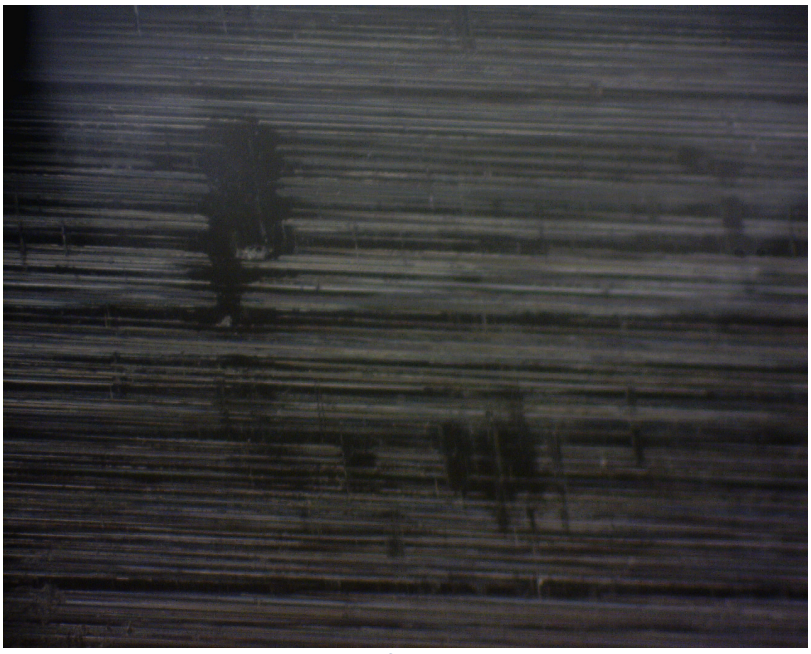
Image 7: Oil filter removal before application

3.1 Tooth flank examination on 11.08.2018 before the REWITEC® W100® surface treatment

All imprints where evaluated under a light microscope with 200 times magnification at different points of the tooth flank.

- Visible surface roughness
- Visible micropitting

Image 8: BC-03 HSS **before** REWITEC® treatment on 8.11.2017



- Pronounced surface roughness
- Evident pitting

Image 9: BC-03 LSIS **before** REWITEC® surface treatment on 8.11.2017

4. Evaluation of the Gear Surface after the REWITEC® surface treatment

On 09.01.2018 the wind turbine was inspected again. Prior to that time, the wind turbine was able to reach different load conditions. After switching off the drive gear, the previously marked positions on the tooth flank were inspected again. Then, a second imprint was taken of the corresponding tooth flanks of the wind turbine.

4.1 Surface imprints of gear tooth flanks after the REWITEC® surface treatment

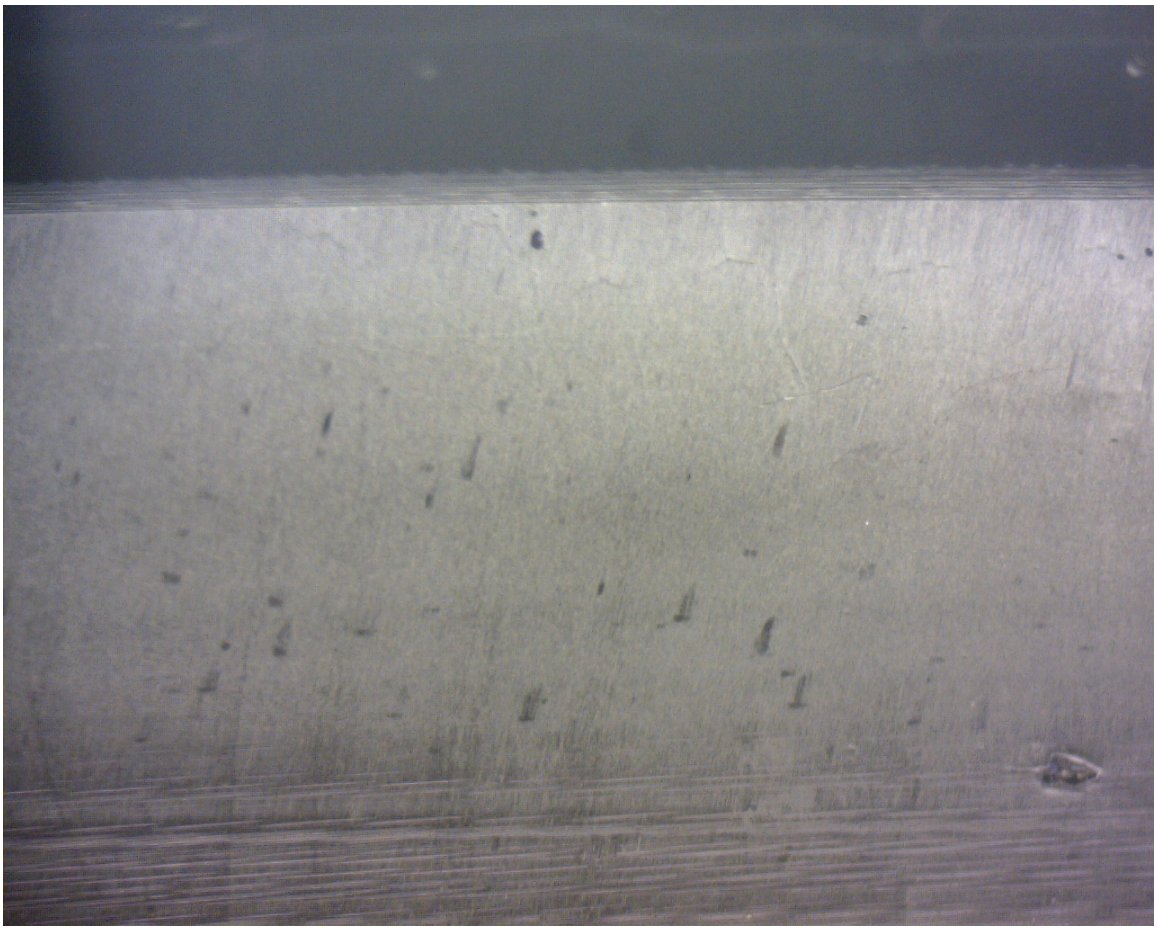


Image 10: Surface imprint of BC-03 HSS **after** the REWITEC® surface treatment on 09.01.2018

- ✓ Surface is visibly smoother
- ✓ Micropitting reduced or eliminated partially

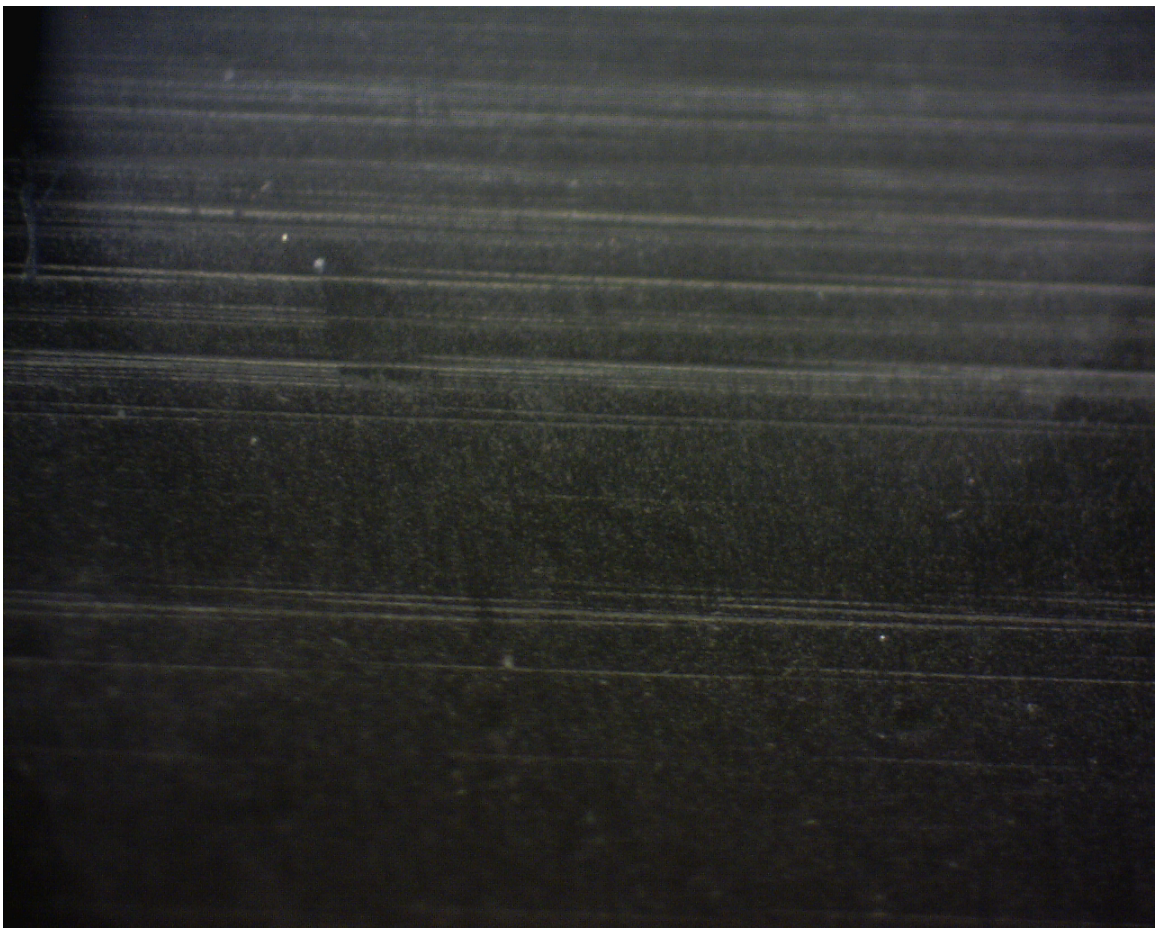


Image 11: Surface imprint of BC-03 LSIS **after** the REWITEC® surface treatment on 09.01.2018

- ✓ Improved surfave appearance
- ✓ Evident pitting reduction

4.2 Image comparison

4.1 HSS of BC03 before and after the REWITEC® surface treatment

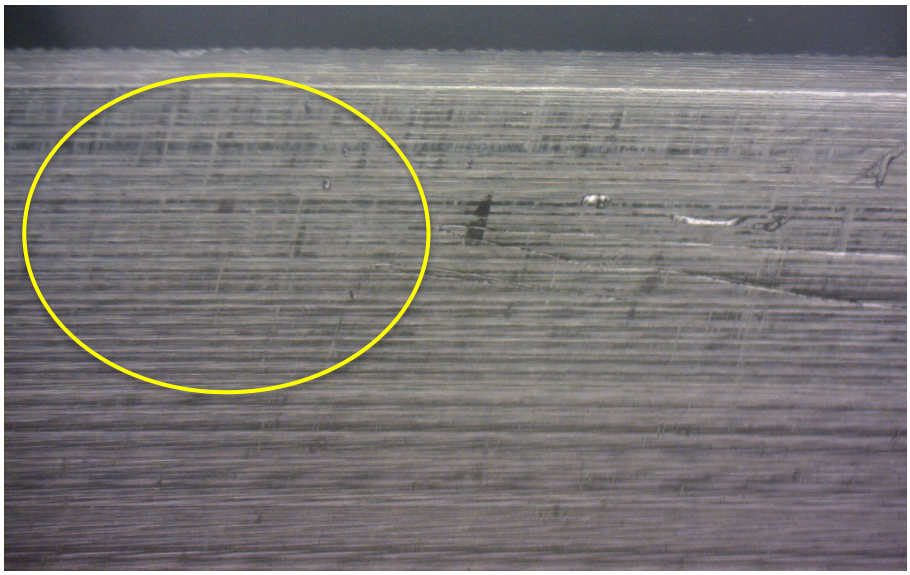


Image 9: BC-03 HSS **before** the REWITEC® surface treatment on 8.11.2017

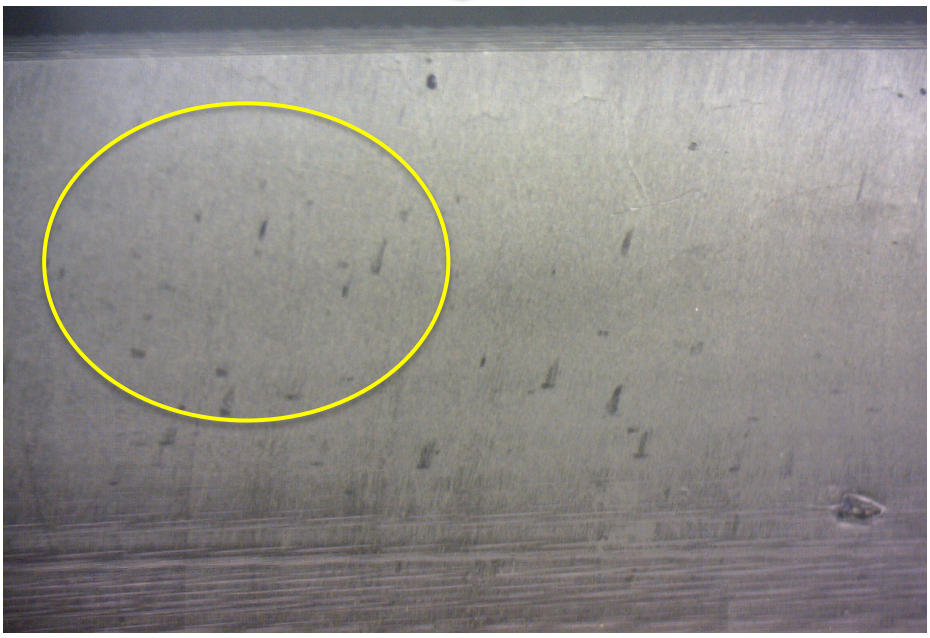


Image 10: BC-03 HSS **after** the REWITEC® surface treatment on 09.01.2018

4.2 LSIS of BC03 **before** and **after** the REWITEC® surface treatment

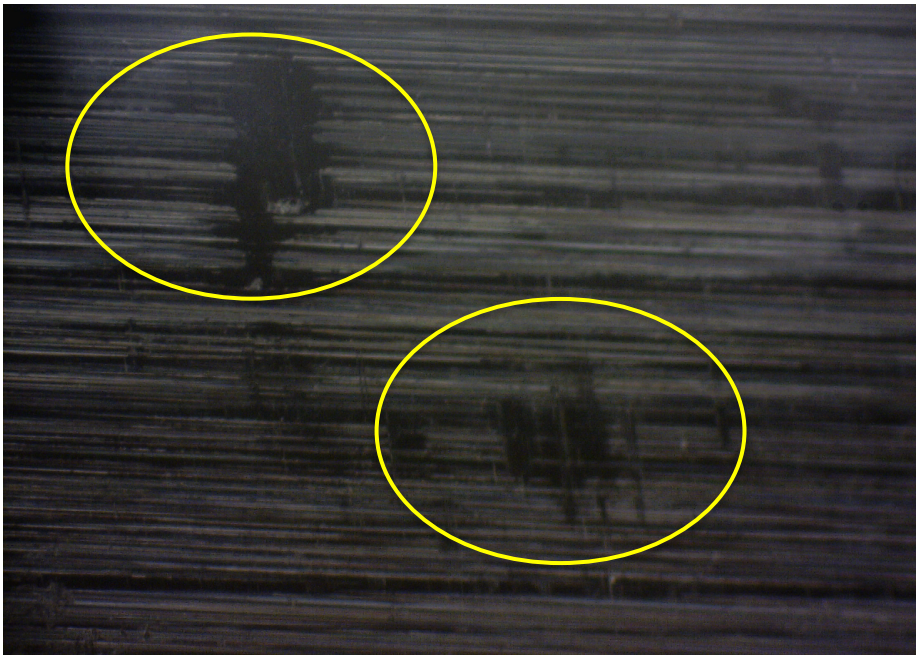


Image 11: BC-03 LSIS **before** the REWITEC® surface treatment on 8.11.2017

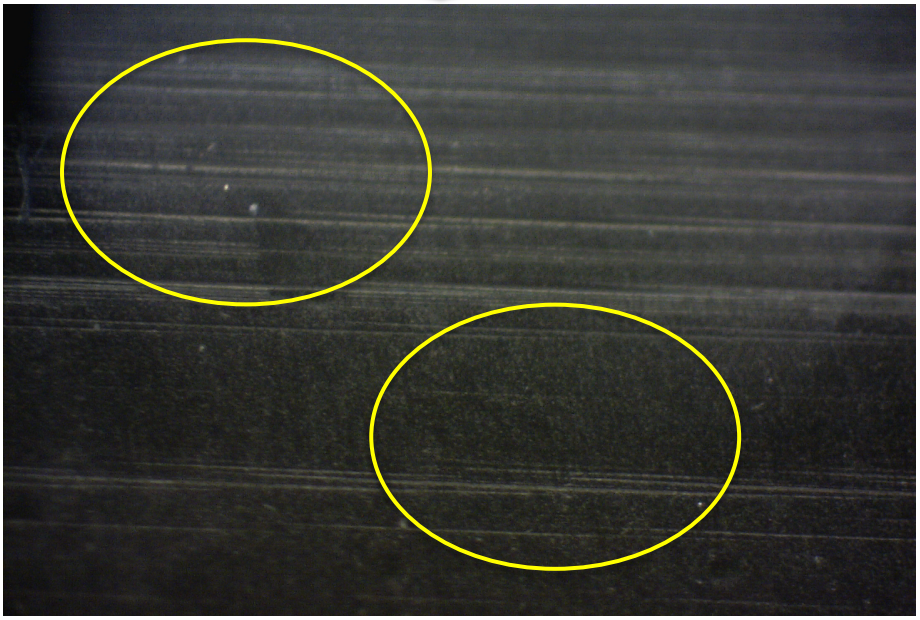


Image 12: BC-03 LSIS **after** the REWITEC® surface treatment on 09.01.2018

5. Results

Based on the evaluations of the surface imprints **before** the treatment with REWITEC® DuraGear® W100 on 08.11.2017, and the surface imprints **after** the REWITEC® application (09.01.2018), the obtained findings and results are the following:

- ✓ The worn surfaces have been recovered significantly
- ✓ The run through marks, micro-pitting and seizures were reduced and partially closed

5.1 Summary

The aim of the REWITEC® application was to improve the surface structure of the previously damaged gears, which has been achieved clearly.

The improved surface structure of the gears and bearings should increase substantially the life of the gearbox system.

The practical results confirm several scientific studies by the Universities of Mannheim and Giessen.

To continue with the protection of the gearbox for many years to come, a post treatment with REWITEC® is recommended every year.

Acknowledgments:

We would like to thank the entire technical crew of Statkraft for their support and the opportunity.

A special thanks to the staff from New Wind Services. These results were obtained thanks to their commitment and great performance.

To all of you our heartfelt thanks!

6. Attachment – surface roughness analysis

In the following attachment, you will find an independent analysis from the University of Giessen with a Keyence VK 9700 Microscope.

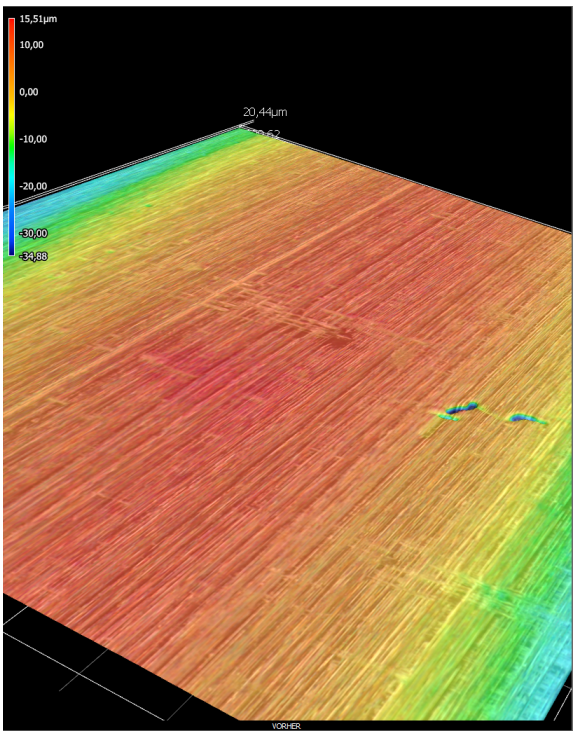


*Image 13: surface of LSIS **before** on 08.11.2017*

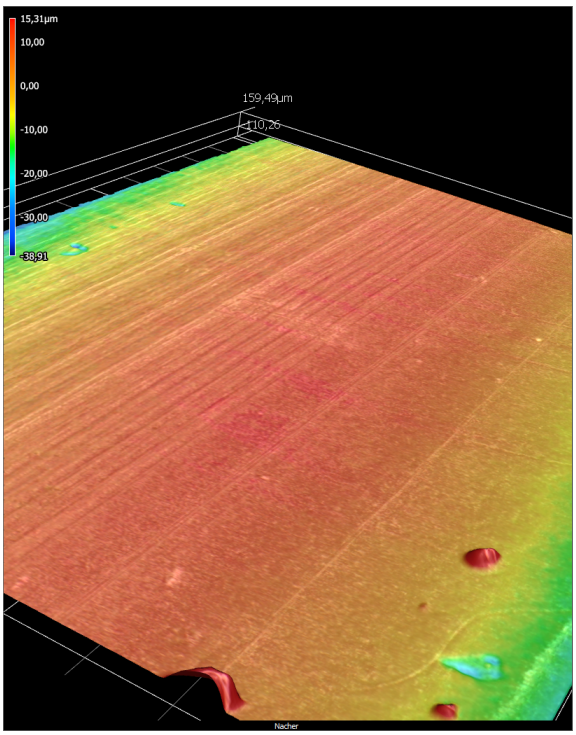
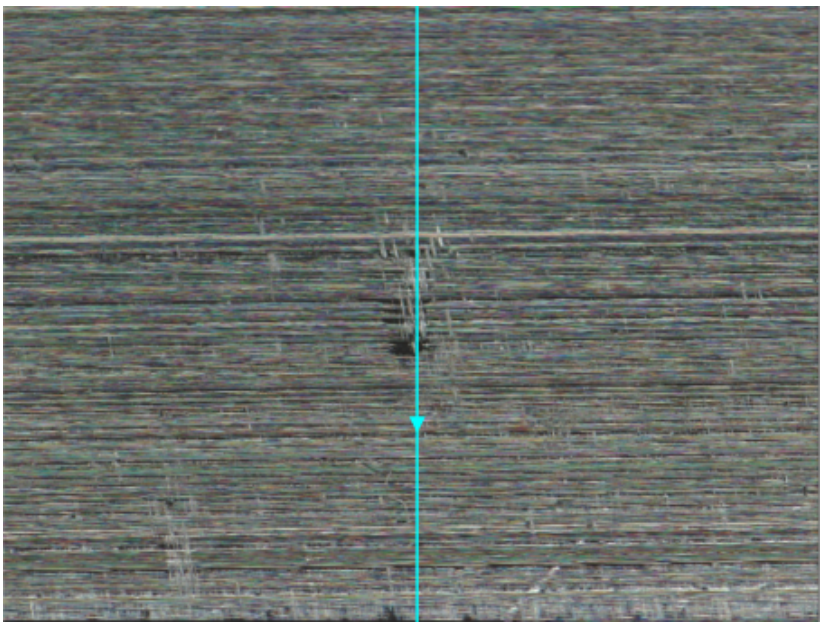


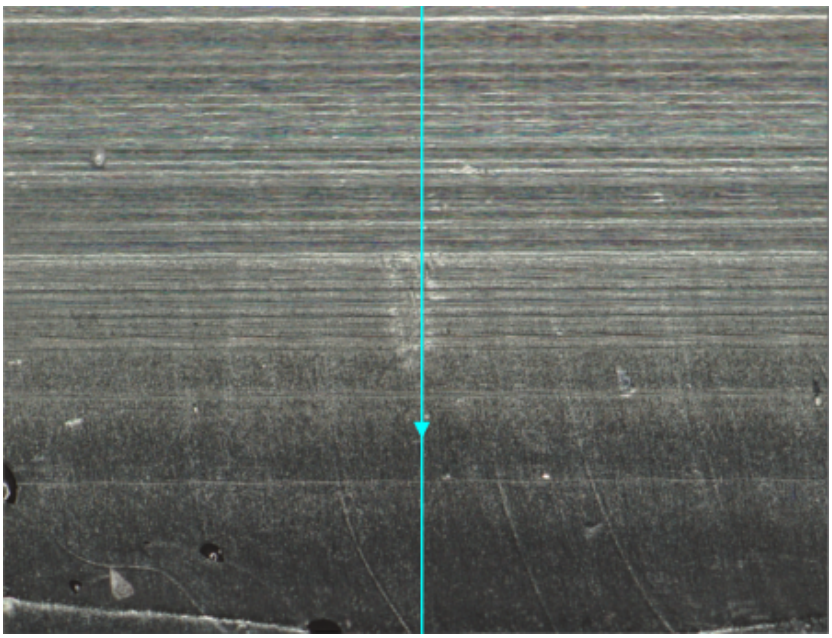
*Image 14: surface of LSIS **after** on 09.01.2018*

6.1 Results of surface roughness reduction



Nr.	Name Messung	Messwert	Einheit
1	Ra	0,66	µm
2	Rz	3,69	µm

*Image 18: **before** surface treatment on 08.11.2017*



Nr.	Name Messung	Messwert	Einheit
1	Ra	0,52	µm
2	Rz	3,26	µm

*Image 19: **after** surface treatment on 09.01.2018*

✓ **Over 21 % of surface roughness improvement (Ra)**