# Trial Report Investigating the Sealing Material Durability of Radial-Shaft-Seals


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|---|---|
| **Client:** | **Rewitec GmbH**<br>Herr Stefan Bill<br>Dr.-Hans-Wilhelmi-Weg 1<br>D-35633 Lahnau<br>stefan.bill@rewitec.com |
| **Research Center:** | Center of Competence Tribology, University of Applied Science Mannheim<br>Leitung: Prof. Dr. Jürgen Molter |
| **Person Responsible:** | Michael Ruland |
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# Aim of Analysis and Test Execution

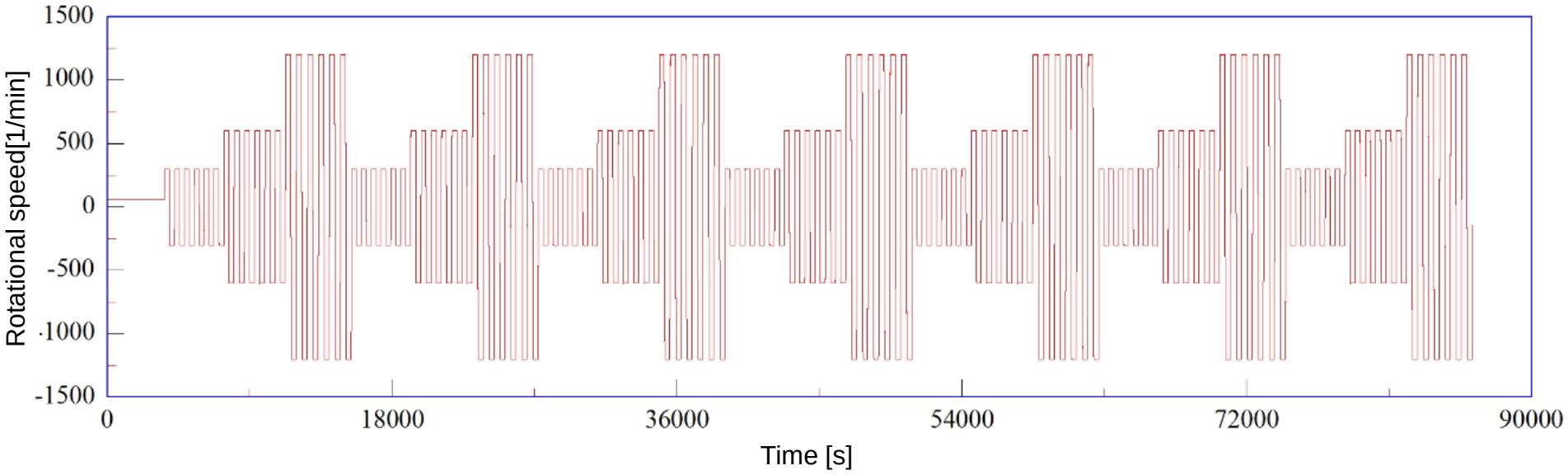
The tribology center of competence analised the friction and abrasion behaviour of radial-shaft-seals at room temperature (25°C) for the client, in regard to different lubricants, utilising the XCT test rig.
Using these tribological trials, assertions about material durability of tested sealingrings are to be made.

For this purpose the radial-shaft-sealingrings (type FKM) are mounted onto the XCT test rig with the help of an adapter. Using this adapter it is possible to flood the experimental space in front of the sealingring sealing lip with the tested motor oil (10W40, with and without Rewitec-additive).
To guarantee a constant intermixing, the lubrication system is designed as a circulating oil lubrication system. A standard needlebearing inner ring (type IR30x35x16, material 100Cr6) is used as antibody.
The used test program can be structured into the following steps.

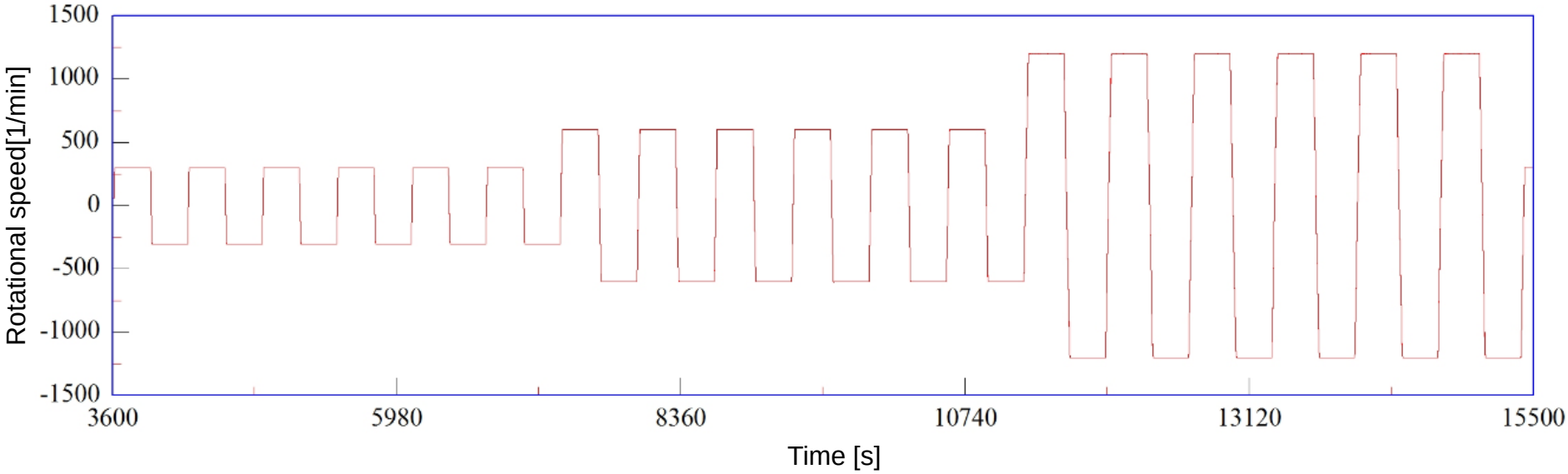
- Constant rotary motion by  60 1/min for 60 minutes (intake works)
- Reversing rotary motion (meaning constant rotary motion for five minutes in positive rotary direction, followed by a change in direction for another five minutes, and so on) at a rotational speed of ± 300 1/min for about 60 minutes.
- Reversing rotary motion (meaning constant rotary motion for five minutes in positive rotary direction, followed by a change in direction for another five minutes, and so on) at a rotational speed of ± 600 1/min for about 60 minutes.
- Reversing rotary motion (meaning constant rotary motion for five minutes in positive rotary direction, followed by a change in direction for another five minutes, and so on) at a rotational speed of ± 1200 1/min for about 60 minutes.

Steps 2 and 4 repeat themselves 7 times respectively (slide 3). In order to assess material durability, the tested sealingrings are then examined for significant signs of abrasion, using digital microscopy.

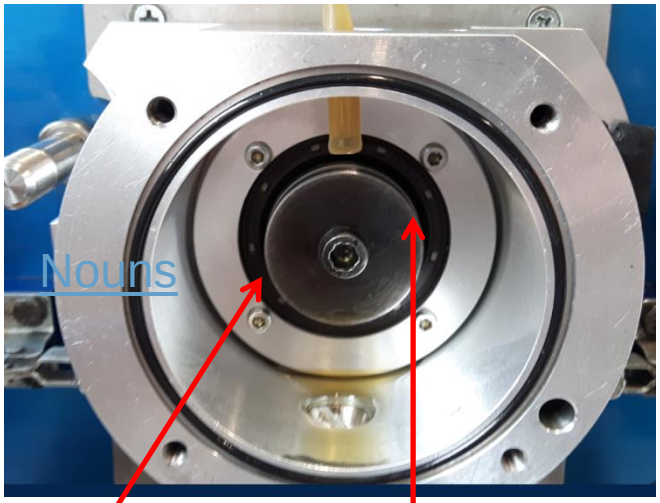
# Test Program with Cycle 1 to 7 and Intake Works



# Test Program with Cycle 1



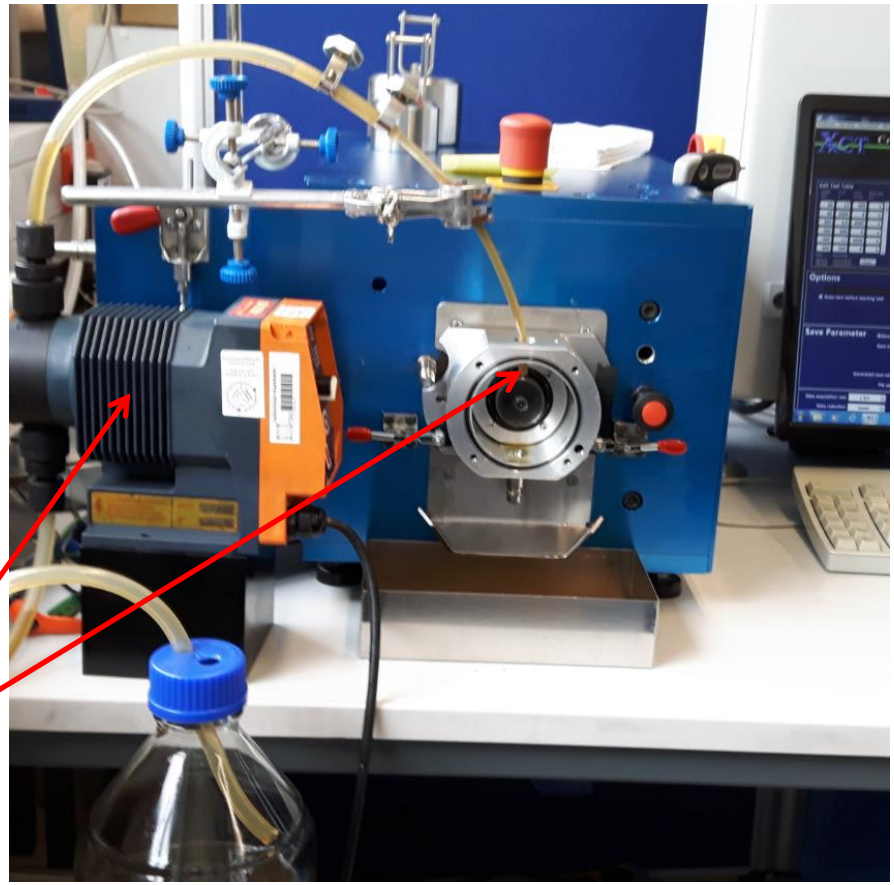
# Test Set-up




Radial sealing (type FKM)

Needle roller bearing bushes (100CR6)

Recirculating oil lubrication system

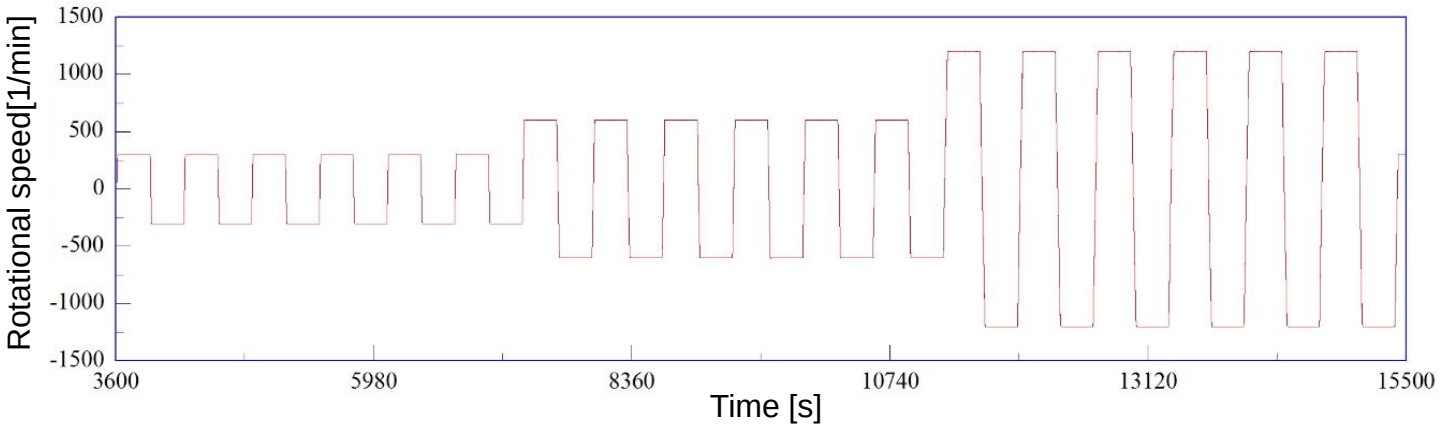


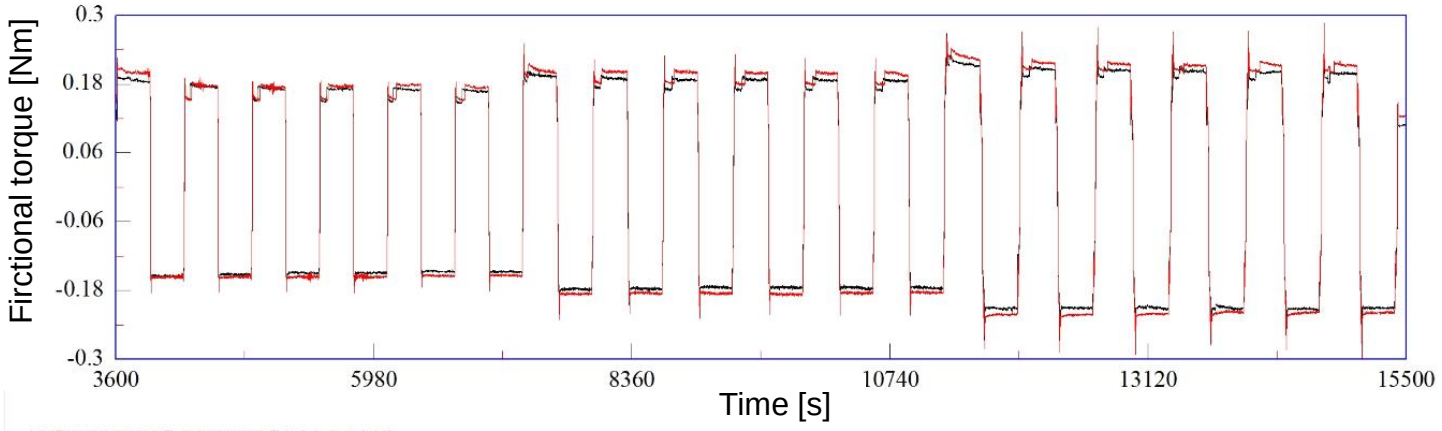
# Configured Trial Parameters at the XCT Test Rig

| | |
|---|---|
| Contact geometry: | Surface contact |
| Form of motion: | Reversing or linear sliding |
| Base body: | Needlebearing (ø = 35 mm, material = 100Cr6) |
| Anti body: | Radial-shaft-sealingring (ø = 35 mm, b = 7,00 mm, Typ FKM ) |
| Slidingvelocity: | 0,55 m/s; 1,10 m/s; 2,20 m/s |
| Normal force: | Preload force of the radial-shaft-seal |
| Temperature: | Roomtemperature |
| Friction condition: | Mixed friction |
| Lubrication: | Immersion lubrication |
| Test duration: | 24 h |
| Measured parameter: | Friction torque |

# Measurement Results/ Friction Torque Diagrams

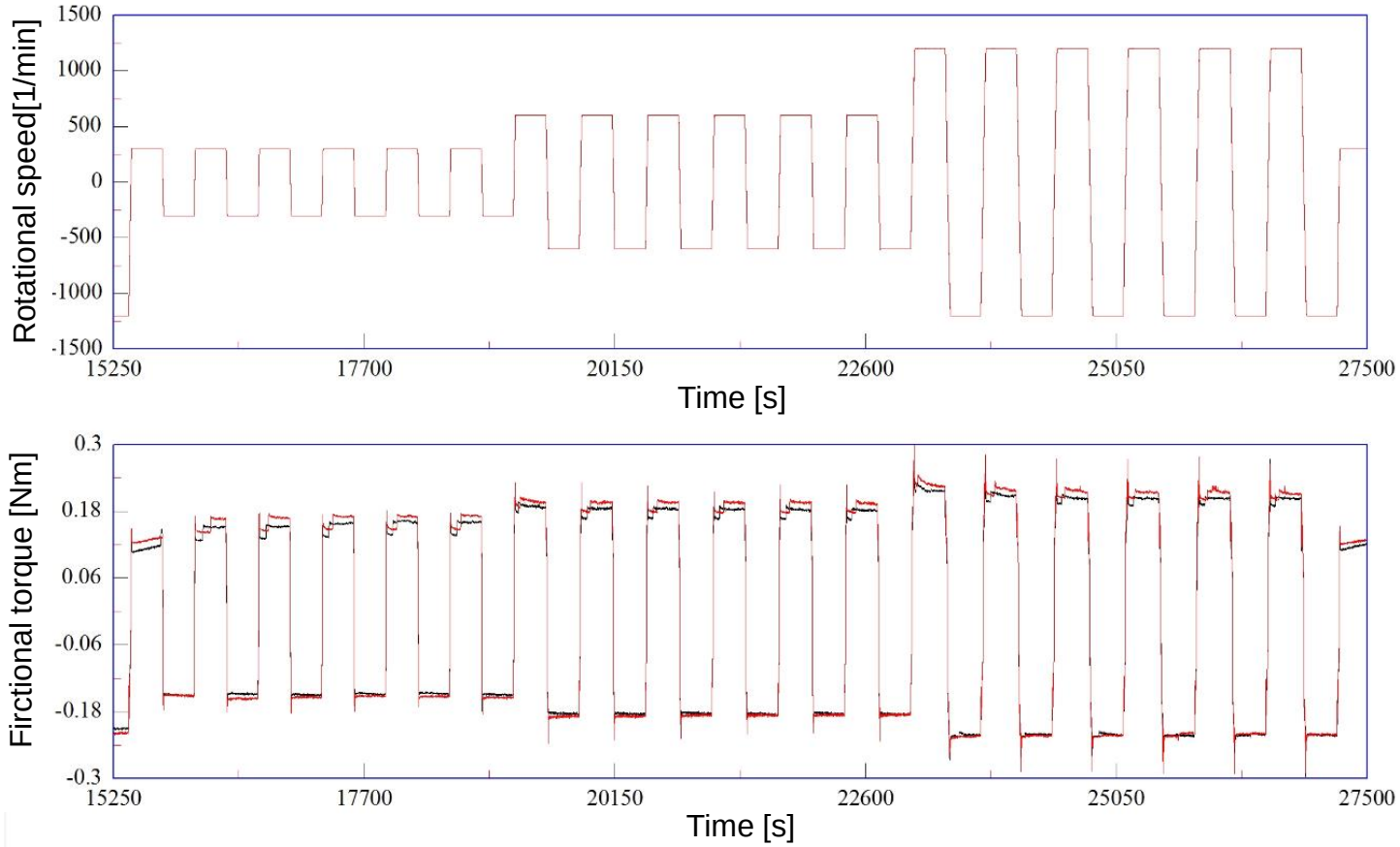
# Measurement Results (1st Cycle)



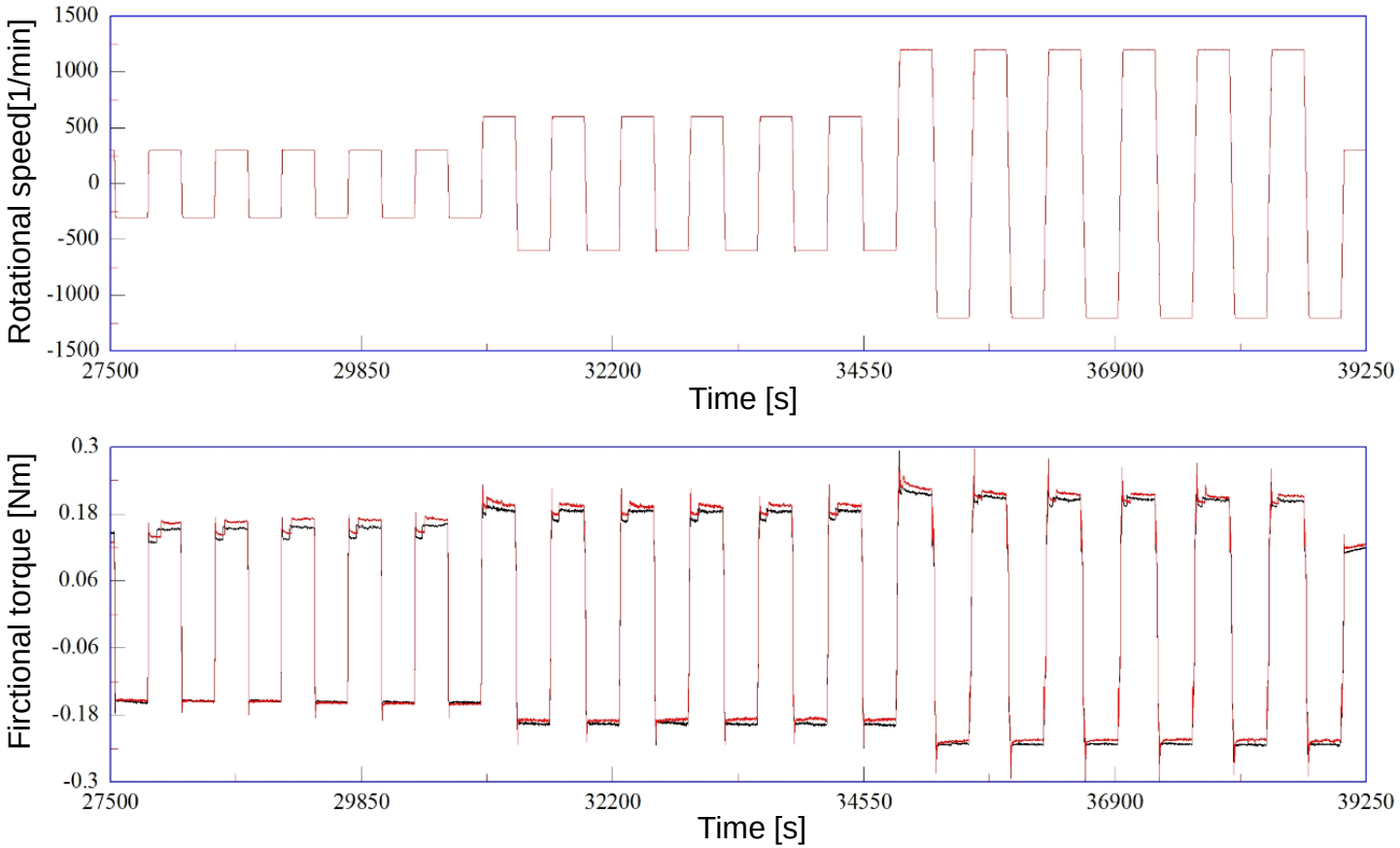

red = Motoroil 10W40 **without** Rewitec addition; black = Motoroil 10W40 **with** Rewitec addition

# Measurement Results (2nd Cycle)



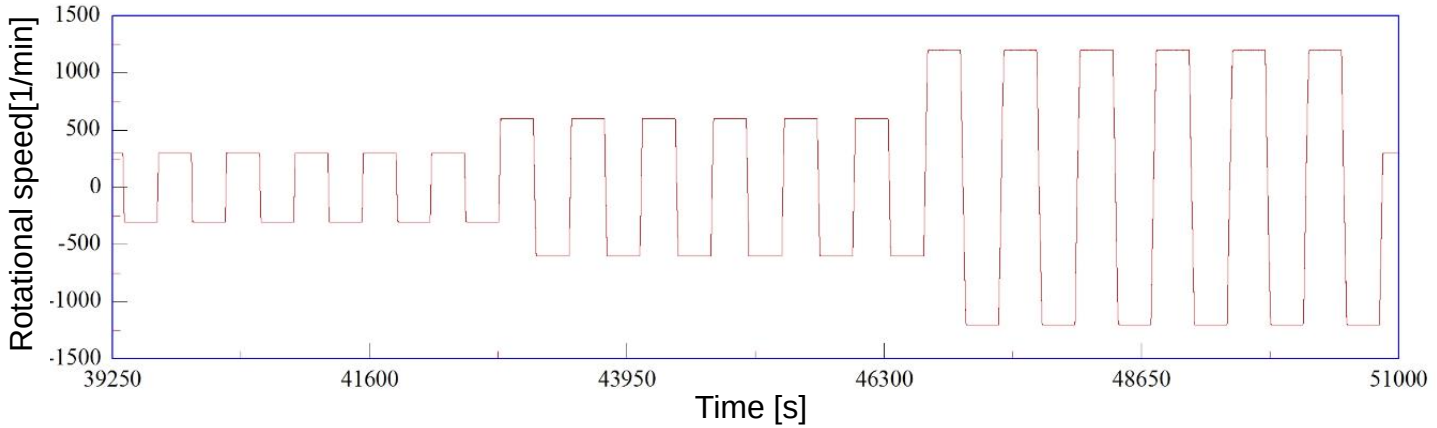

red = Motoroil 10W40 **without** Rewitec addition; black = Motoroil 10W40 **with** Rewitec addition

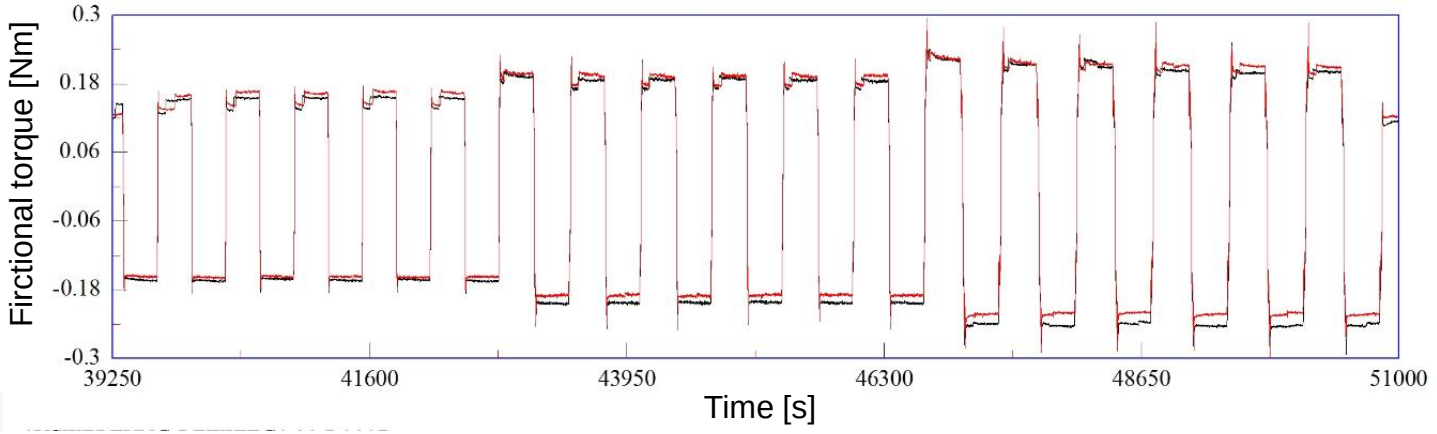
# Measurement Results (3rd Cycle)




red = Motoroil 10W40 **without** Rewitec addition; black = Motoroil 10W40 **with** Rewitec addition

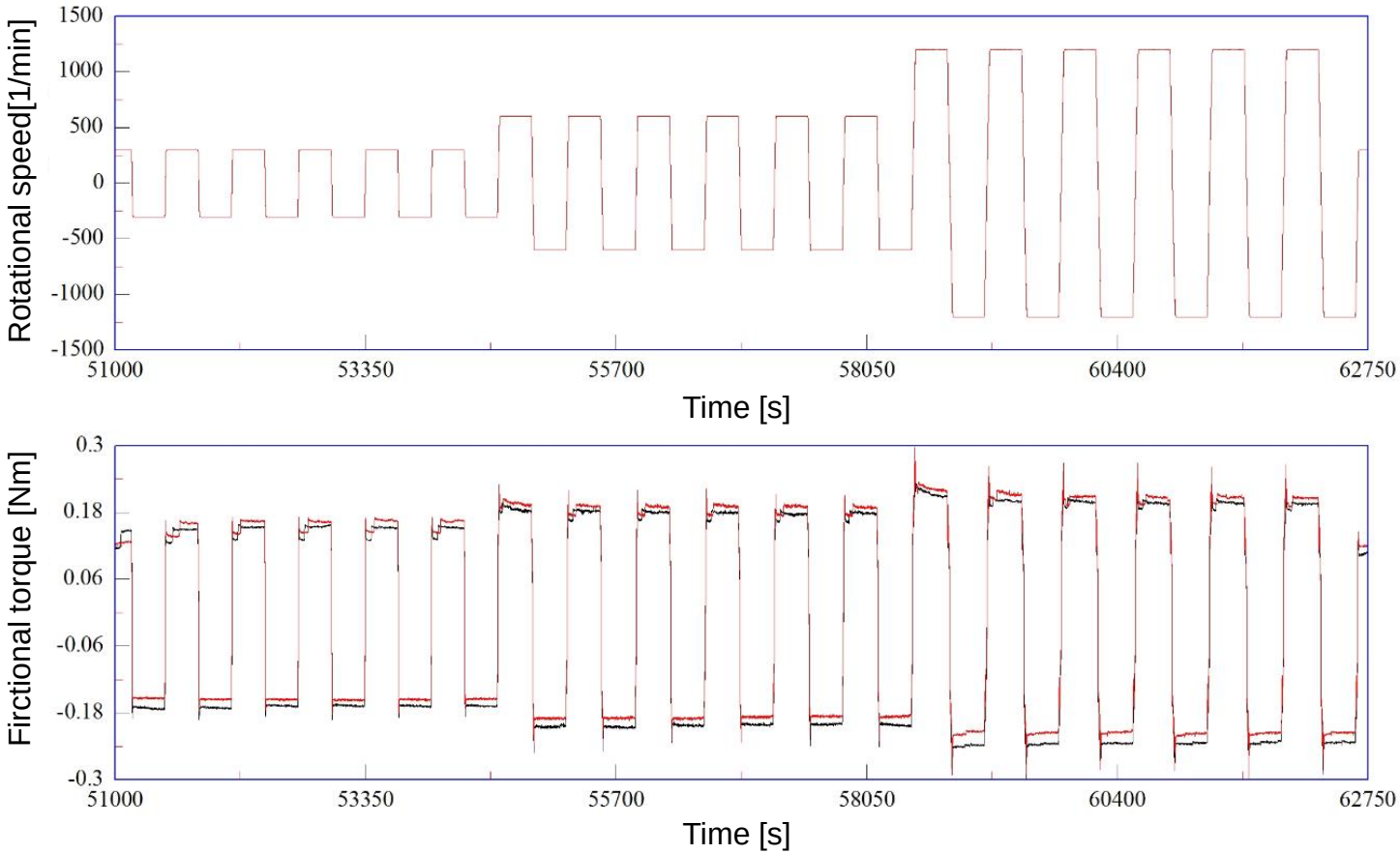
# Measurement Results (4th Cycle)



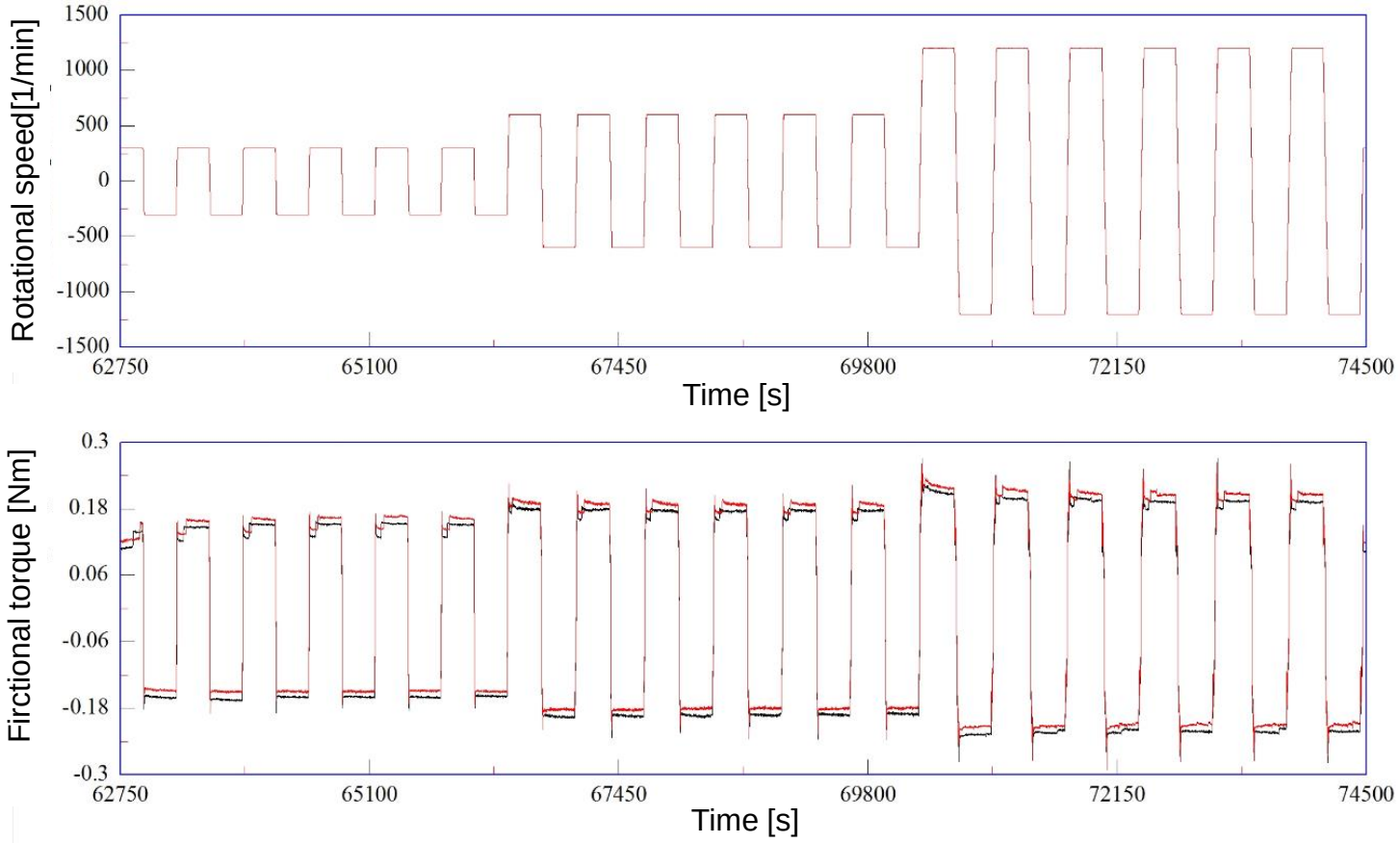

red = Motoroil 10W40 **without** Rewitec addition; black = Motoroil 10W40 **with** Rewitec addition

# Measurement Results (5th Cycle)



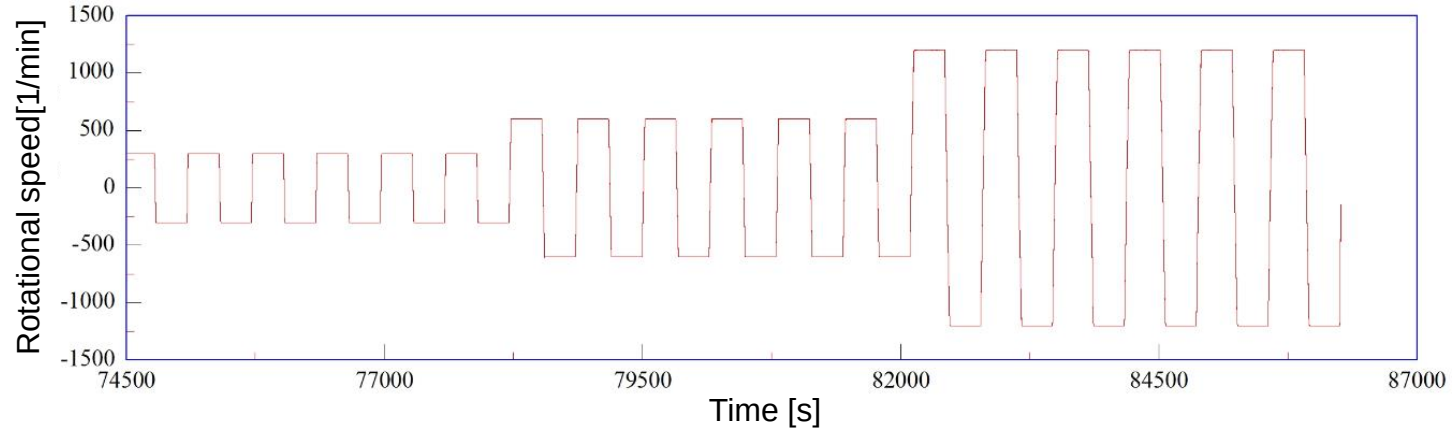

red = Motoroil 10W40 **without** Rewitec addition; black = Motoroil 10W40 **with** Rewitec addition

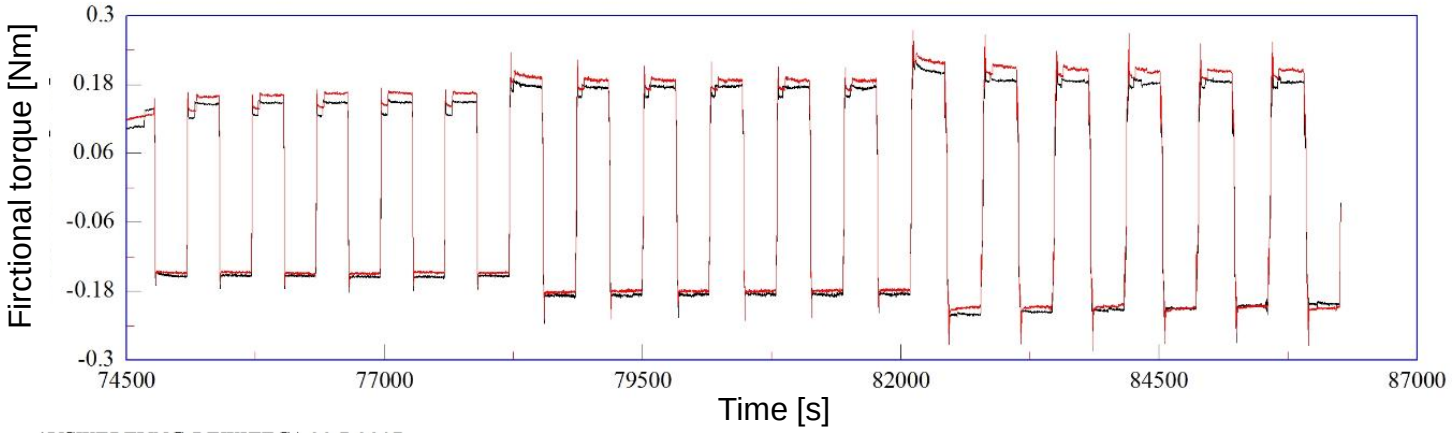
# Measurement Results (6th Cycle)




red = Motoroil 10W40 **without** Rewitec addition; black = Motoroil 10W40 **with** Rewitec addition

# Measurement Results (7th Cycle)




red = Motoroil 10W40 **without** Rewitec addition; black = Motoroil 10W40 **with** Rewitec addition

# Wear Verification using Microscopy

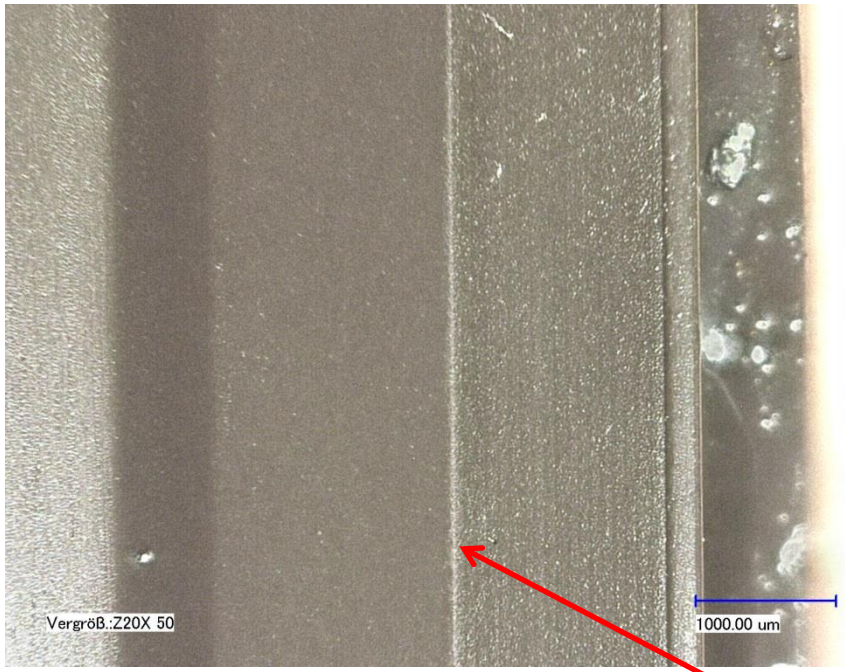
# Microscopic Determination of the Radial Sealings (5-times magnified)

Without Rewitec addition

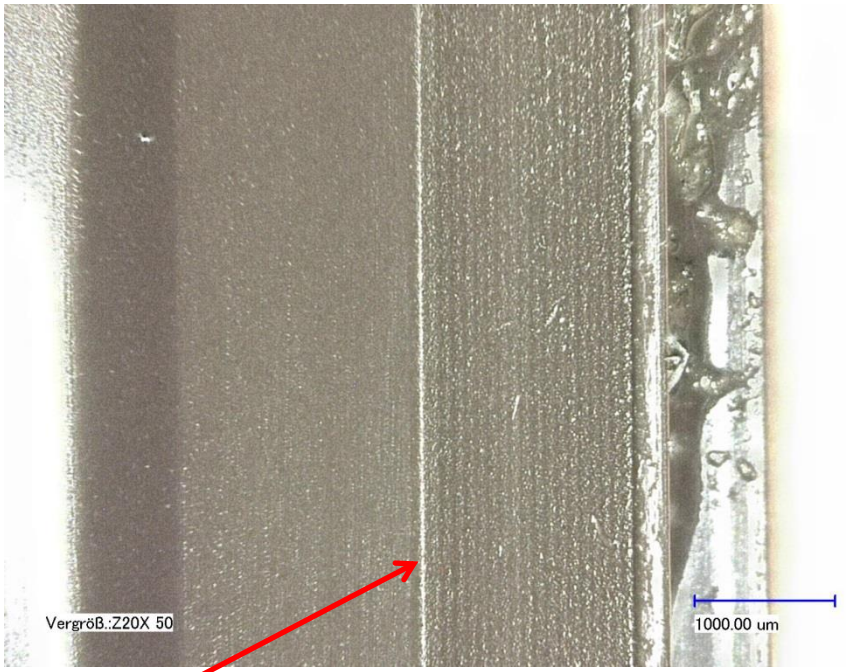

With Rewitec addition

# Microscopic Determination of the Radial Sealings (50-times magnified)

Without Rewitec addition



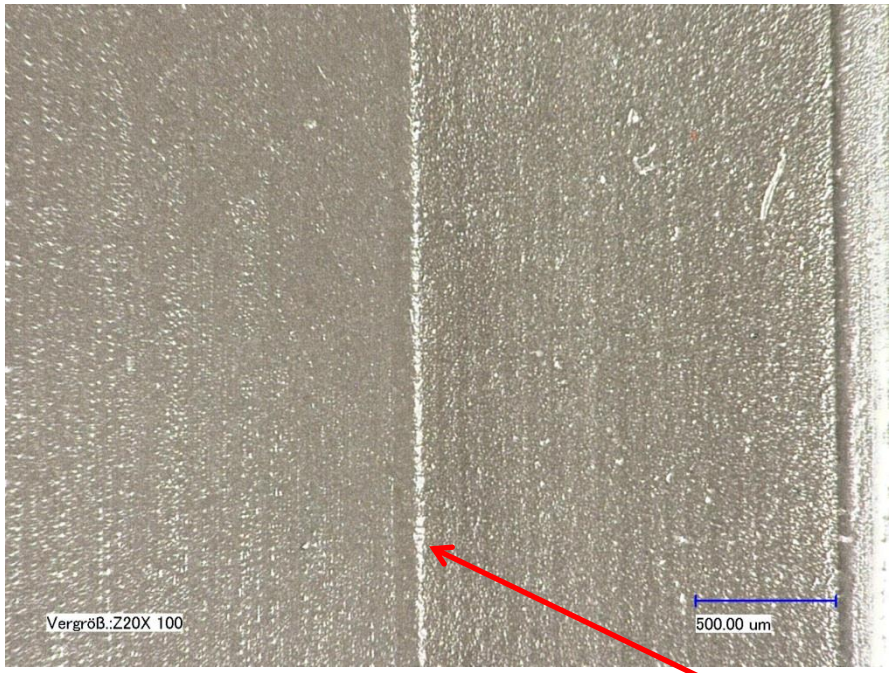

With Rewitec addition



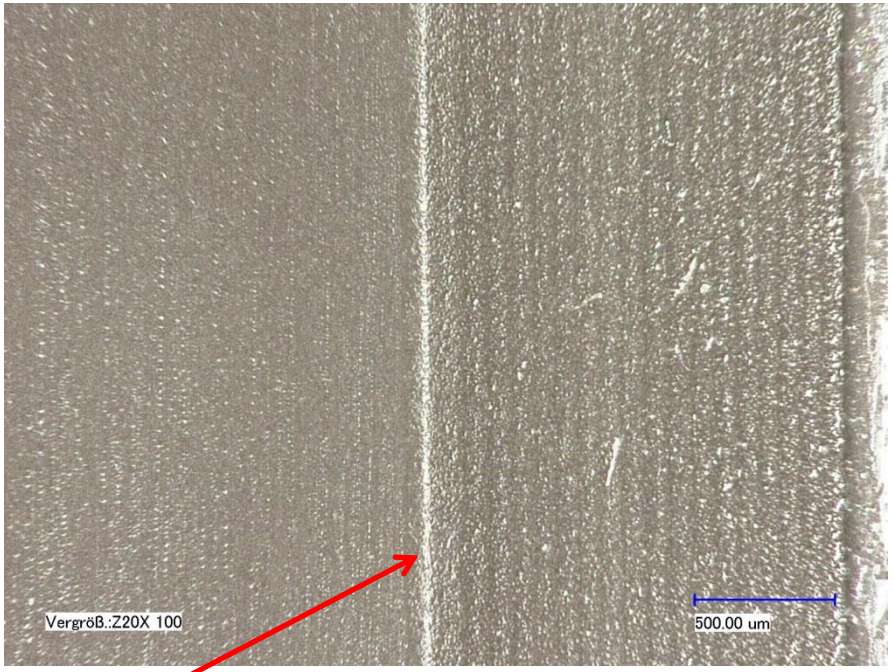

Sealing lip

# Microscopic Determination of the Radial Sealings (100-times magnified)

Without Rewitec addition



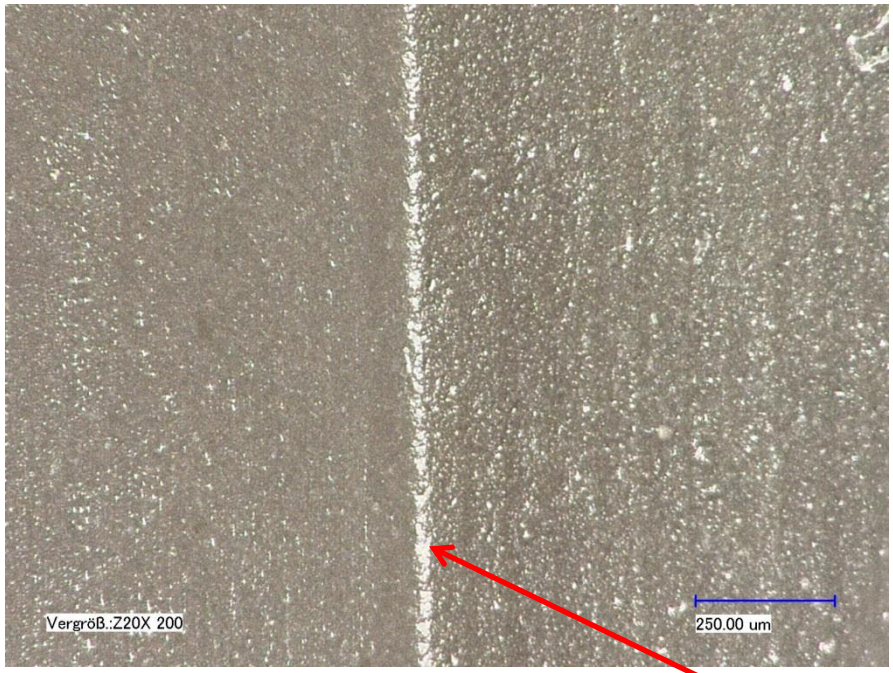

With Rewitec addition



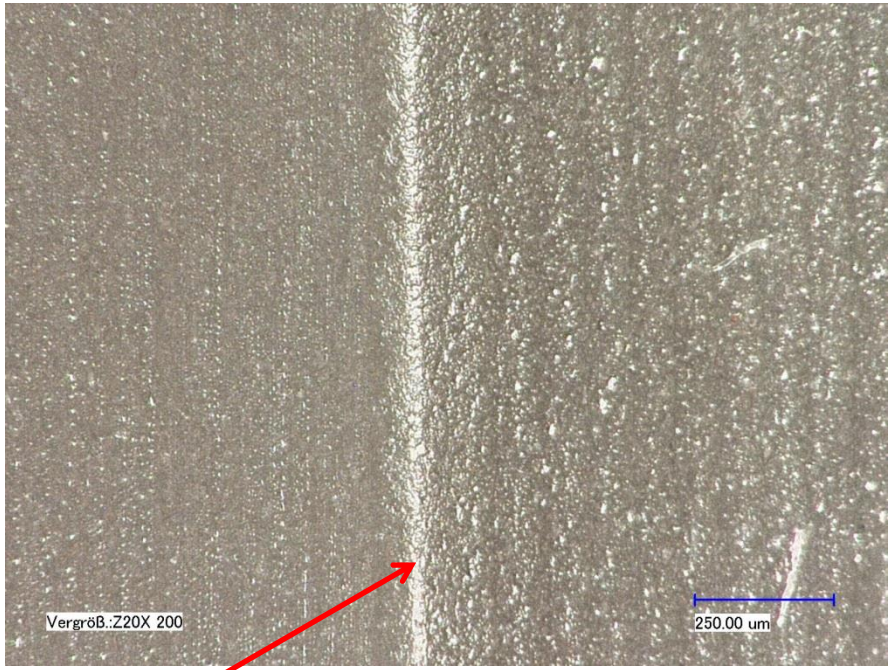

Sealing lip

# Microscopic Determination of the Radial Sealings (200-times magnified)

Without Rewitec addition



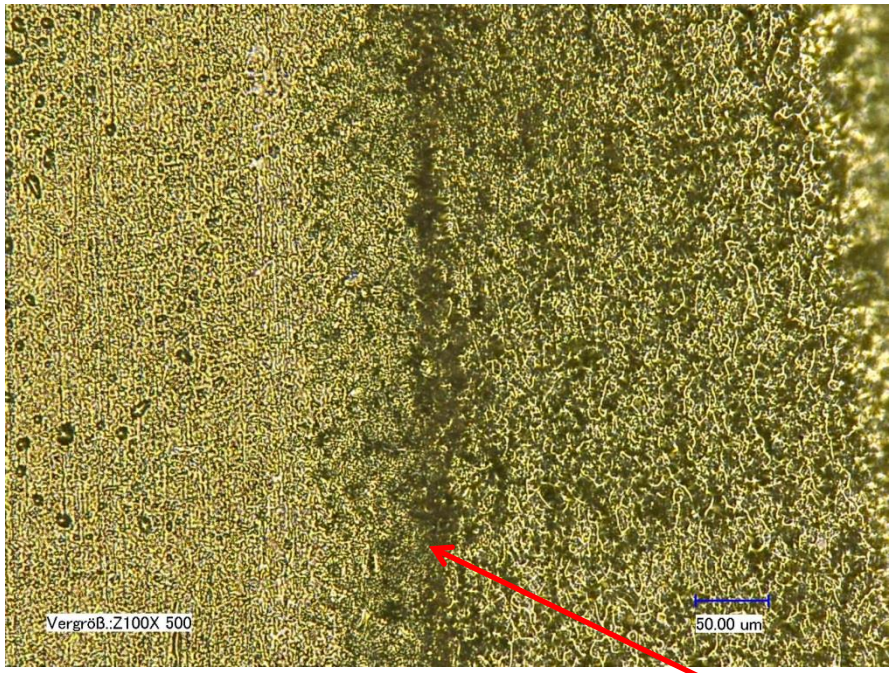

With Rewitec addition



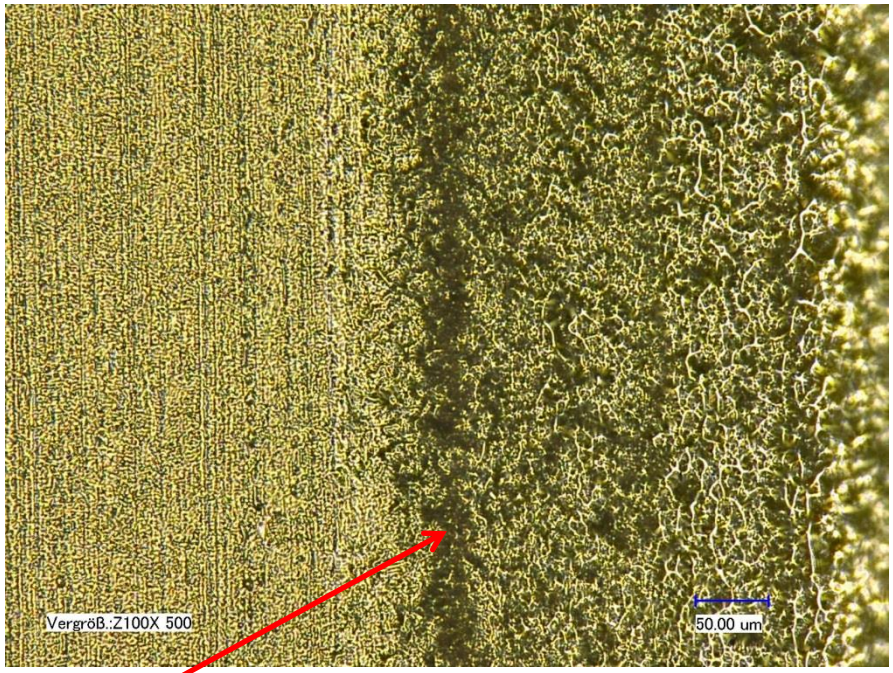

Sealing lip

# Microscopic Determination of the Radial Sealings (500-times magnified)

Without Rewitec addition



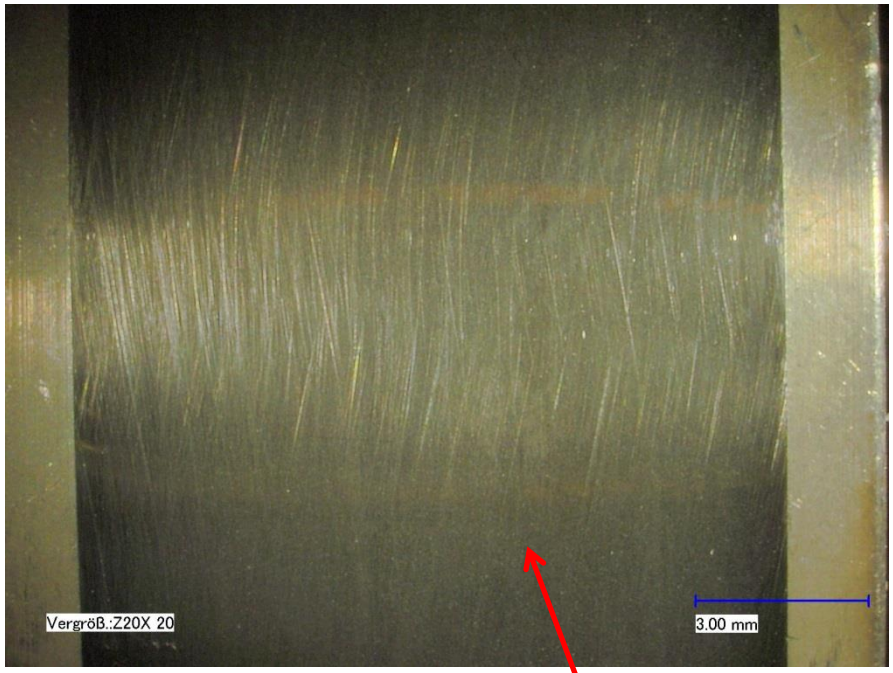

With Rewitec addition



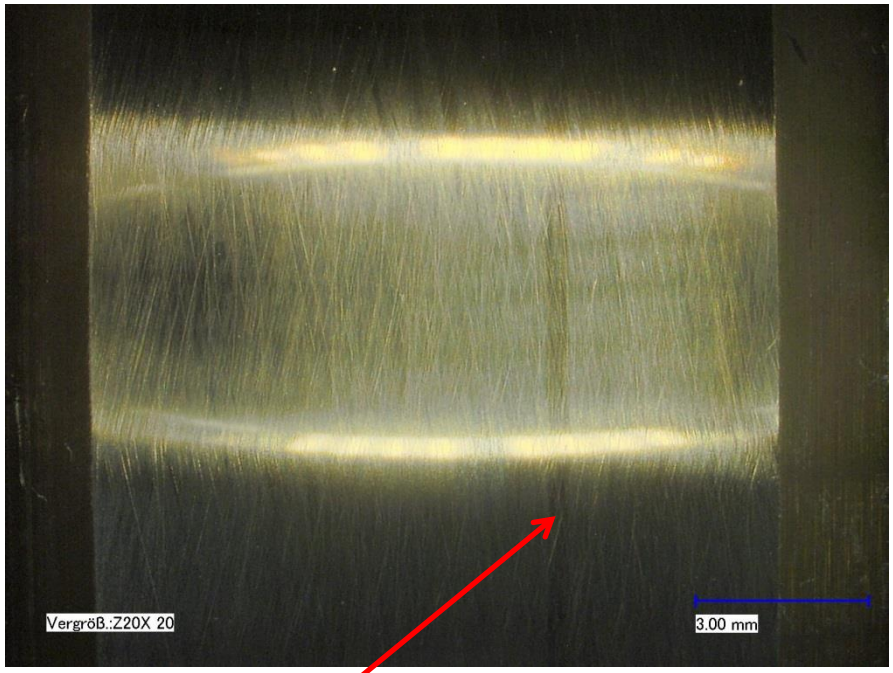

Sealing lip

# Microscopic Determination of the Needle Roller Bearing Bushes (20-times magnified)

Without Rewitec addition



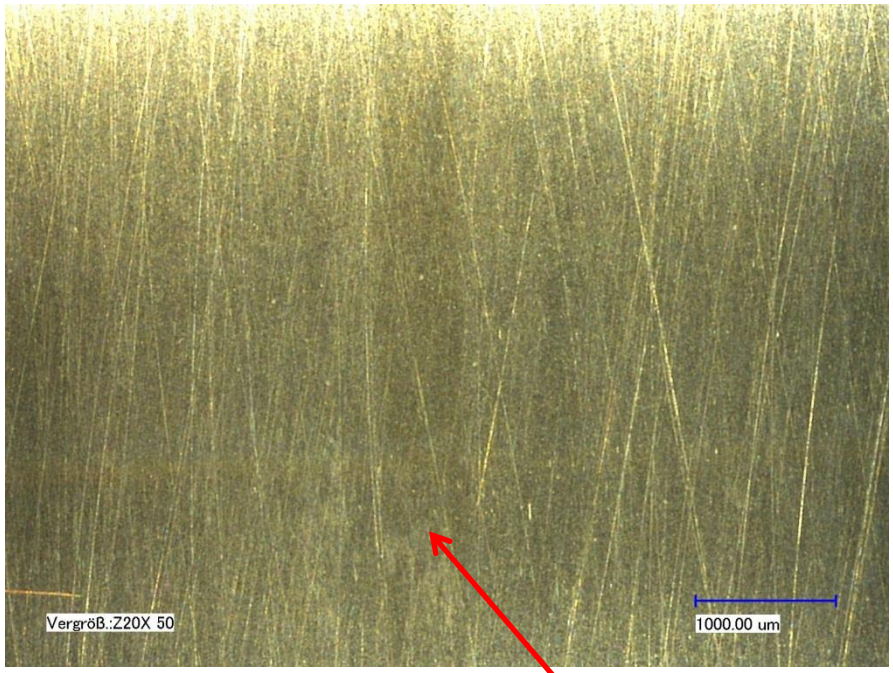

With Rewitec addition




Contact area of the sealing lip

# Microscopic Determination of the Needle Roller Bearing Bushes (50-times magnified)

Without Rewitec addition

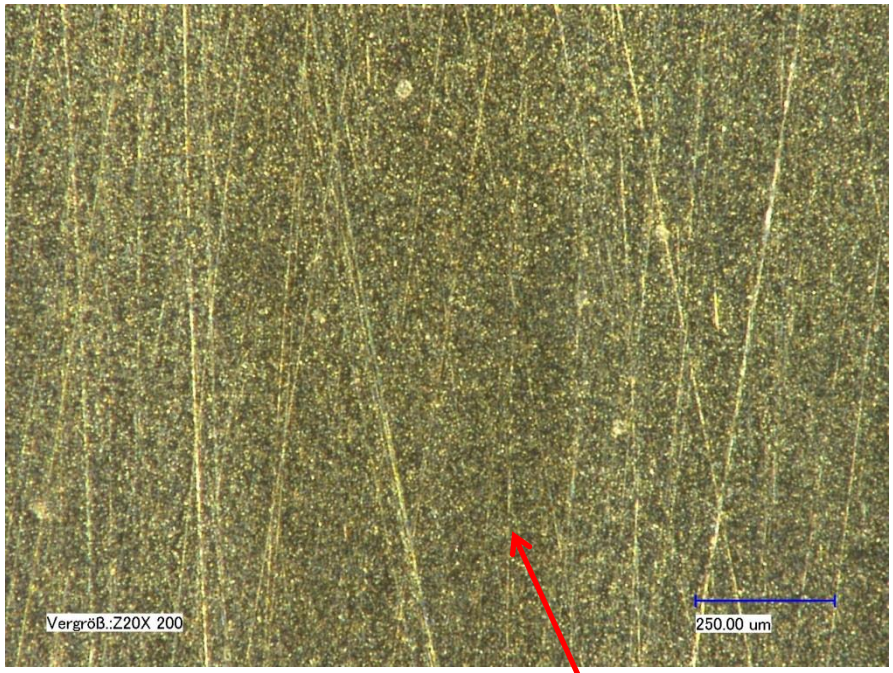



With Rewitec addition

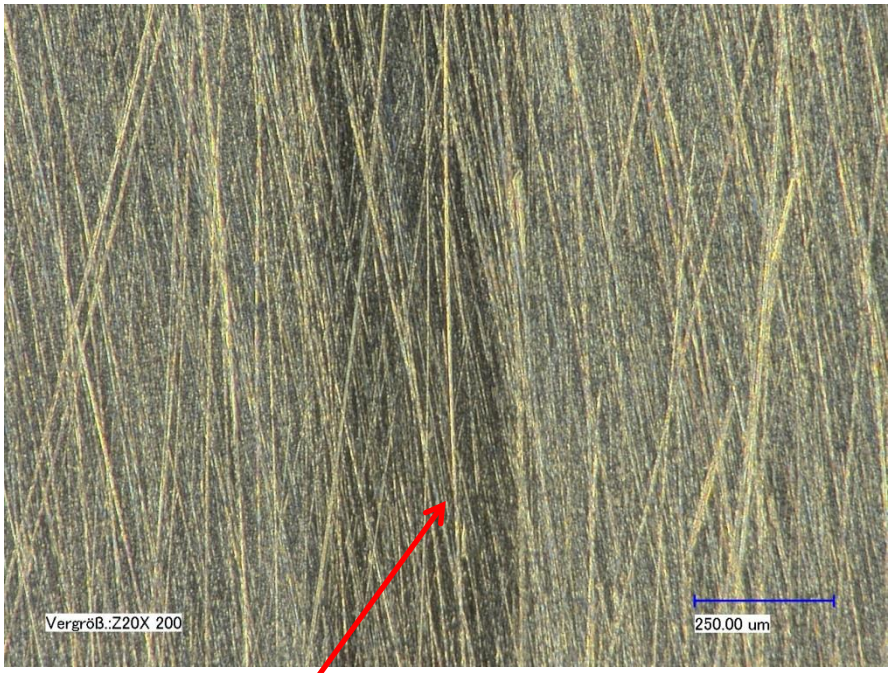

Contact area of the sealing lip

# Microscopic Determination of the Needle Roller Bearing Bushes (200-times magnified)

Without Rewitec addition



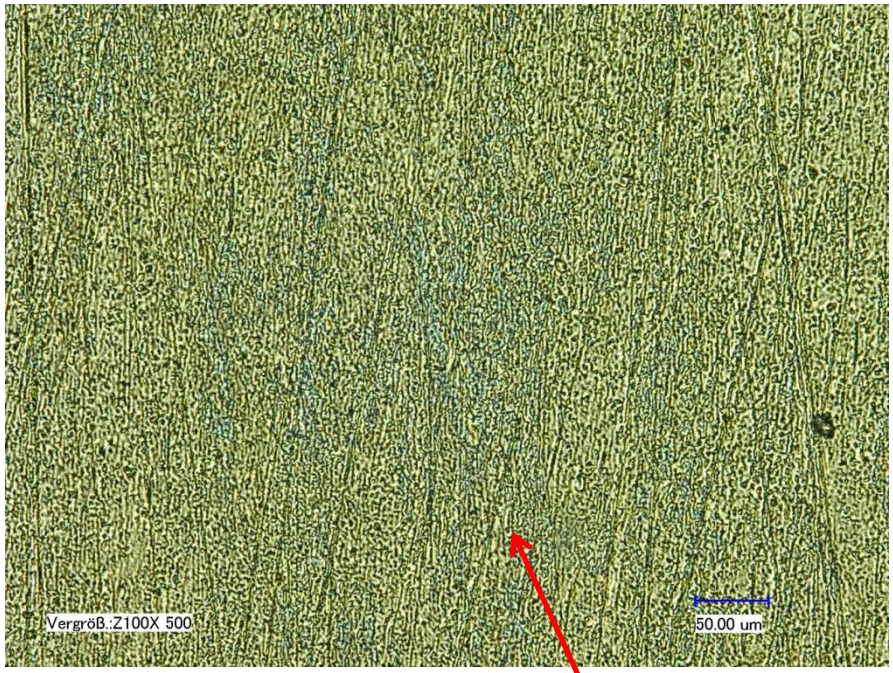

With Rewitec addition



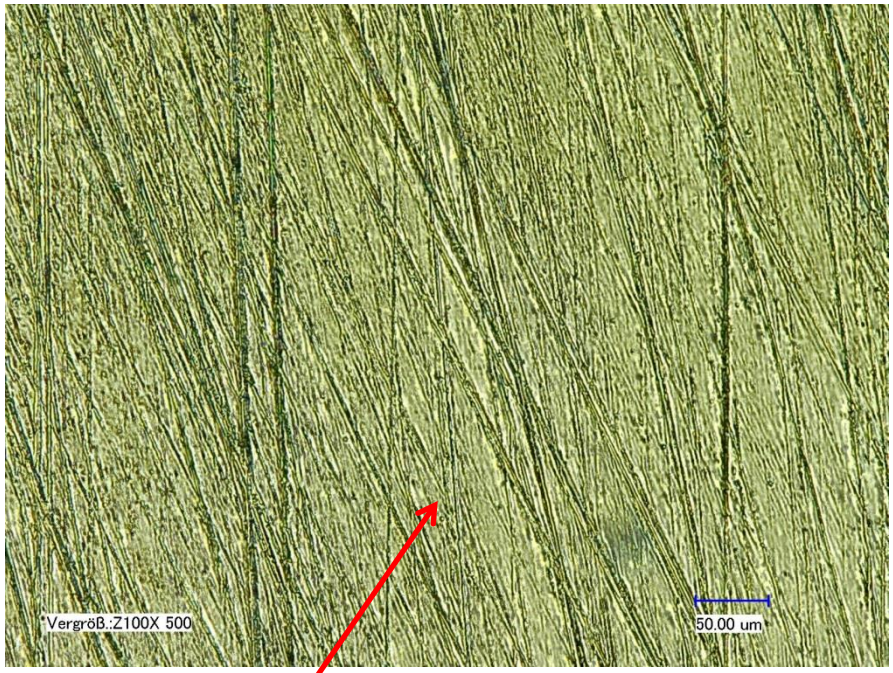

Contact area of the sealing lip

# Microscopic Determination of the Needle Roller Bearing Bushes (500-times magnified)

Without Rewitec addition




With Rewitec addition




Contact area of the sealing lip

# Result

The two trials conducted to determine material durability of radial-shaft-sealingrings using motor oil (10W40) with and without Rewitec additives, proved to be very similar in experimental behaviour, in regards to their respective frictional torque curves, as well as their digital microscopical analysis. Within the given trial duration of 24 h, none of the testpairings showed significant signs of abrasion (meaning detectable using digital microscopy), not on the shaft body, nor on the seals sealing lip. Should an examination of higher accuracy be conducted in the course of the project, it is possible to sputter the seals after tribological trials, in order to make REM-analysis possible.

Please note that the tests were conducted as a single determinaton and thusly analysed using only one set of measurements. For a precise and statistical significant scientific statement concerning the material durability of the radial-shaft-sealingrings, it is vital to have access to more trial results, with triple determination being the minimum.
Furthermore, examination of temperature behaviour could prove to be of interest. Constructive adjustments to the adaptation would need to take place beforehand though.