MODERN MASS FINISHING TECHNOLOGY TO THE OPTIMIZED TRIBO-PARTNER

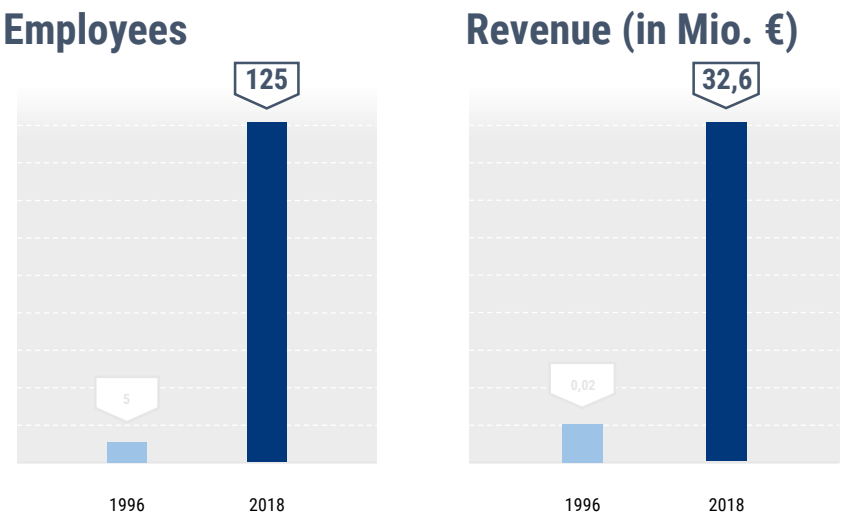
FLORIAN REINLE, ADVANCED DEVELOPMENT & TRIBOLOGY

INTRODUCTION PRESENTATION / 2020

OTEC

OVERVIEW

- Technology leader in mass finishing
  - Mass finishing = surface processing by relative motion workpiece←→ Granulate
  - Worldwide distribution
  - Machinery development & process equipment distribution
- Mid-sized, family-run company from Straubenhardt (Baden-Württemberg / Germany)



OTEC

OVERVIEW

- New building in 2015
- Lean-Management
- New initiatives in research and development

MASS FINISHING

TECHNOLOGY

$F_N, v_t, \mu,...$

MASS FINISHING

TECHNOLOGY

- Relative motion of granulate and workpiece
- Important factors are normal force, tangential velocity, friction coefficient
- Depending on the selection of the appropriate process tool and the machine parameters, machining target can be achieved
  - Targets: roughness, topography, friction coefficient/sliding properties, wear/residual stress, edge rounding, deburring,...
  - Influence variables: workpiece geometry, material, pre-processes, cost/part,...
- Bulk materials or single clamping

MASS FINISHING

OLD TECHNOLOGY RETHOUGHT

OTEC

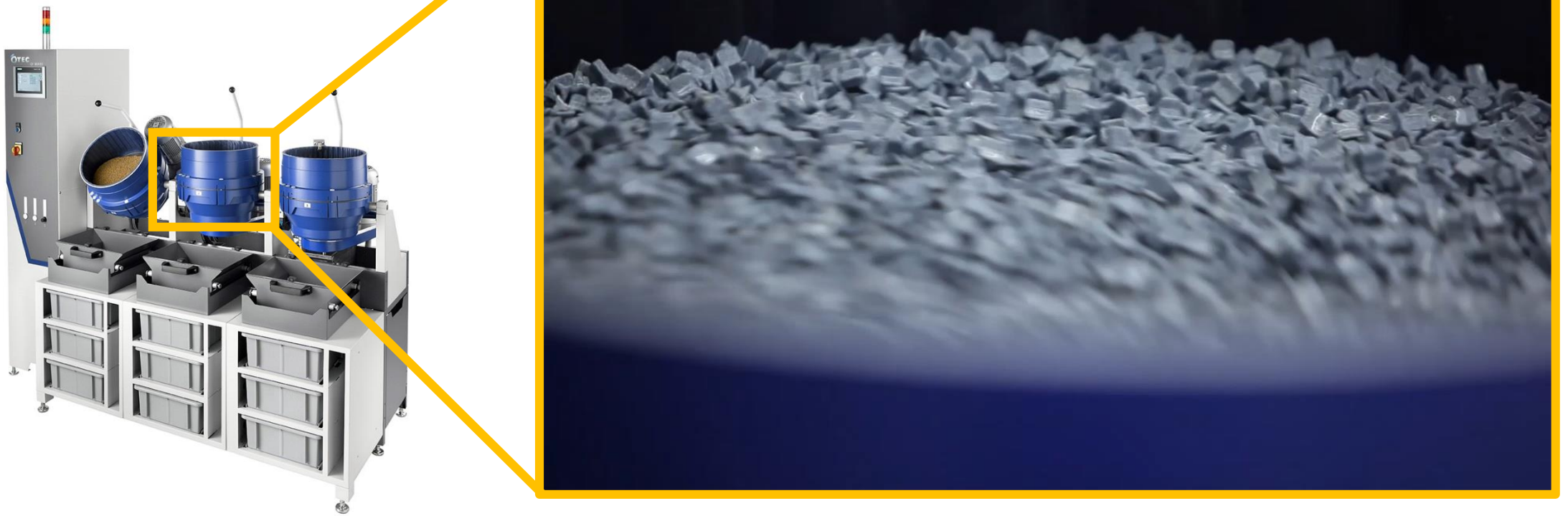
MASS FINISHING

OLD TECHNOLOGY RETHOUGHT

- Development form “simple” vibrating machines to fully automated lines for production systems.
  - Previous: Processing times from several hours to days
  - Today: Range of seconds/minutes
- This also changes targets:
  - Higher-quality workpieces
  - Deburring is only secondary, now improved overall component properties in focus

OTEC MACHINES

SERIES CF – DISC FINISHING



OTEC MACHINES

SERIES CF – DISC FINISHING

- Disk finishing machines for the processing of bulk materials
  - Rotating bottom relative to fixed wall causes flow
  - Torus-shaped flow leads to relative motion
- Deburring, smoothing, grinding and polishing of bulk material – the complete range with only one machine
- Fast amortization due to short processing times
- Easiest operation via touch-screen control
- Absolute reliability thanks to high-quality components
- Machining of workpieces with 0.4 mm (zero-gap system)
- Typical workpieces: jewellery, thread-guiding components, stamping & milling parts

OTEC MACHINES

SERIES DF – DRAG FINISH

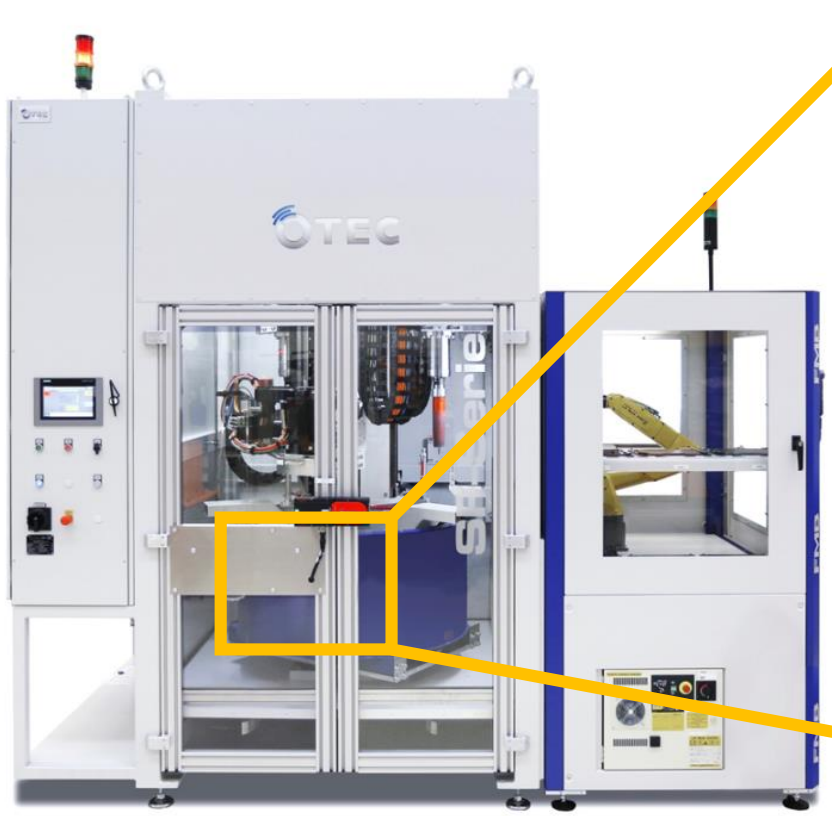
OTEC MACHINES

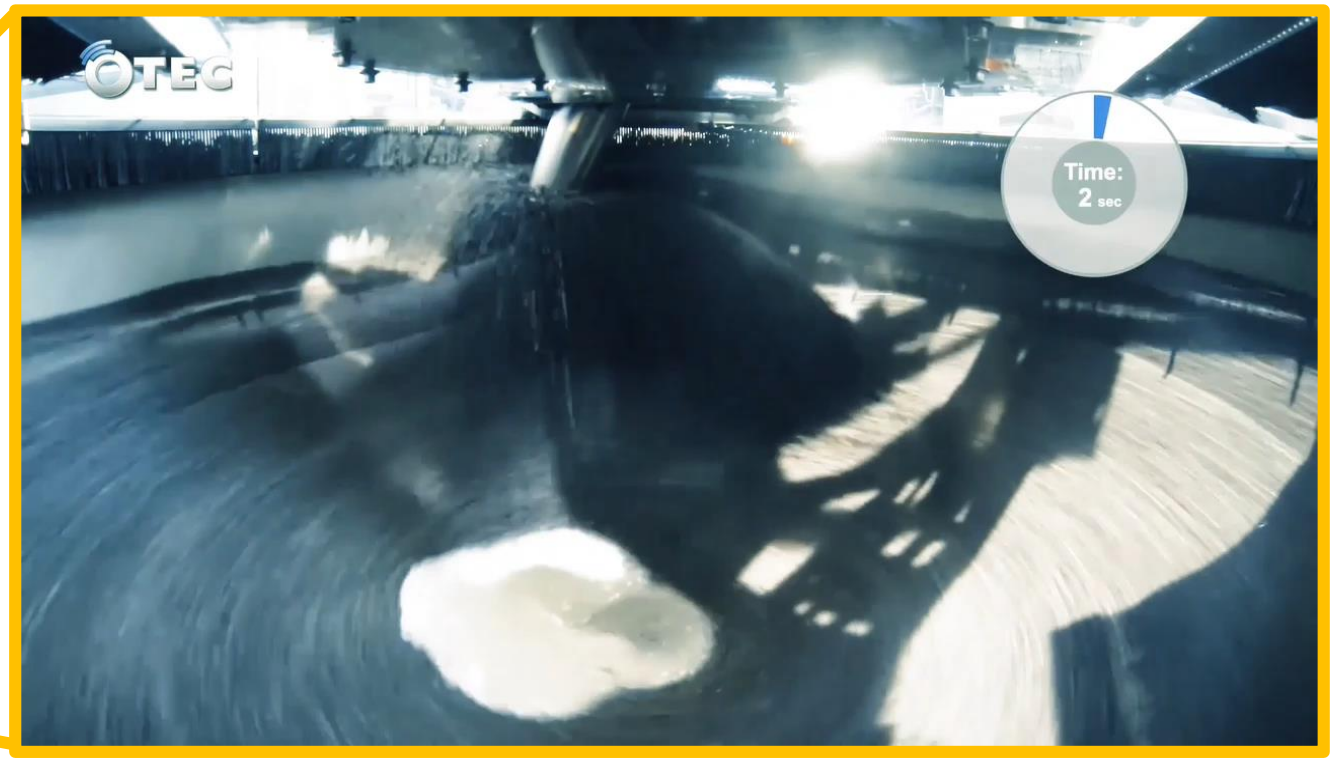
SERIES DF – DRAG FINISH

- Drag finishing machines
  - Fixed granulate container
  - Planetary movement of the workpieces through the granulate
- Flexible series for small or large-scale production
- Meets the highest demands on cost-effectiveness and machining precision
- Processing of separately clamped workpieces
- Thanks to individual clamping of the workpieces, damage is avoided
- Typical workpieces: cutting tools, implants,...

OTEC MACHINES

SERIES SF - STREAMFINISH





Link to the complete video (Youtube)

OTEC MACHINES

SERIES SF - STREAMFINISH

- Fastest process time due to high process forces, flow speed and fully automatic workpiece change
- High processing bandwidth (multiple process steps available)
- Focused processing of individual workpiece areas
- Automatic and manual workpiece loading possible
- High cost-effectiveness
- Optimal integration in line production possible
- Processing of workpieces with a length up to 400 mm and a weight up to max. 60 kg, depending on the machine design
- Number and design of workpiece holders can be configured specific for customers

OTEC MACHINES

SF SERIES – STREAMFINISH - Principle

Angular adjustment
for holder

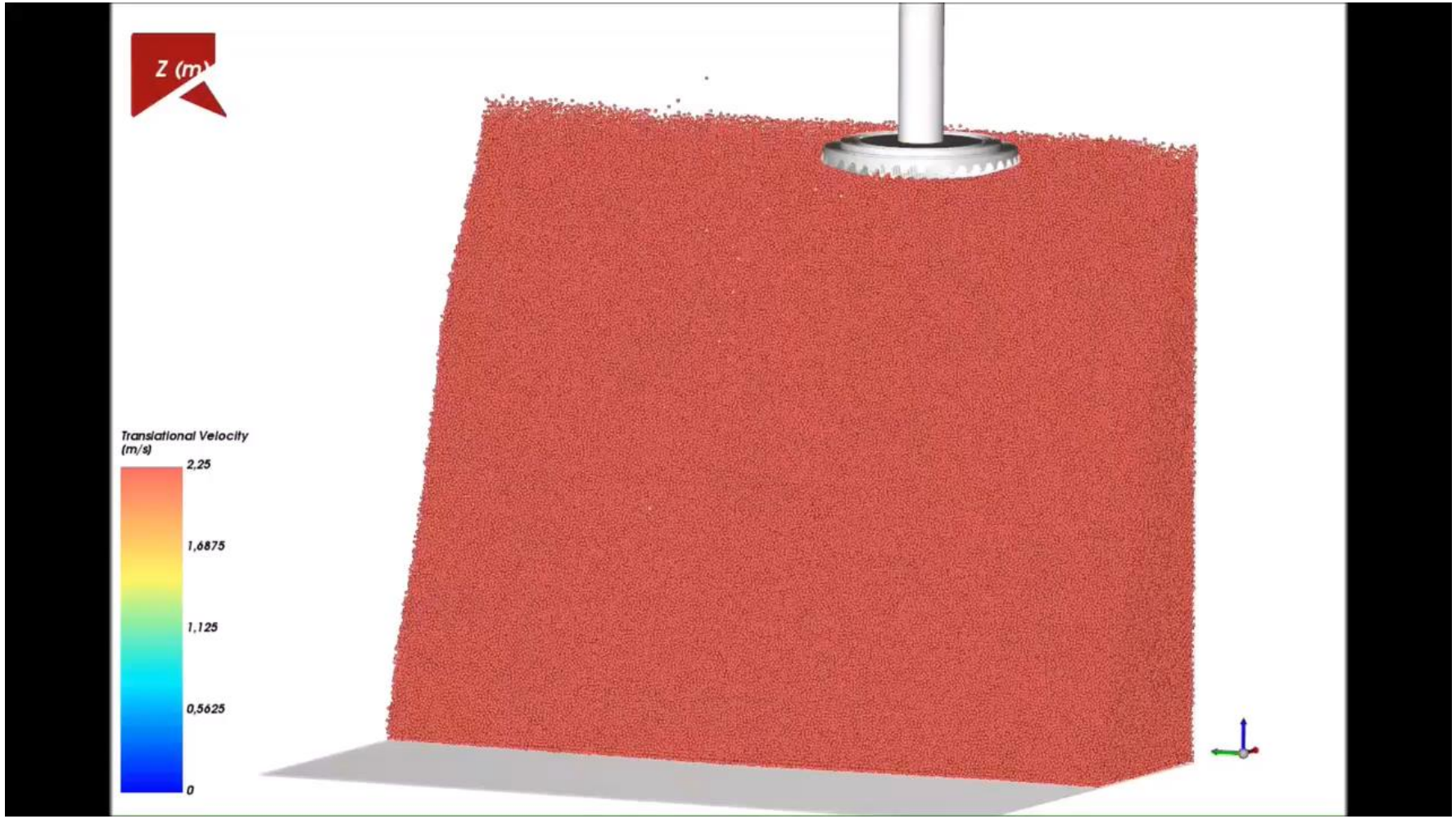
Rotating
workpiece holder

Lifting unit
allows fast component change
within cycle time

Rotating process container
filled with media

PROCESS SIMULATION

STREAMFINISH



PROCESS SIMULATION

STREAMFINISH

- Simulation enables process pre-definition for complicated requirements
- Particle simulation to map the real processes as accurately as possible
- Cooperation with universities and research institutions

OTEC

MARKETS

AUTOMOTIVE INDUSTRY

TOOLMAKING INDUSTRY

STAMPED, TURNED AND MILLED PARTS

AEROSPACE INDUSTRY

MEDICAL AND PHARMACEUTICAL INDUSTRY

CERAMIC AND PLASTIC PARTS

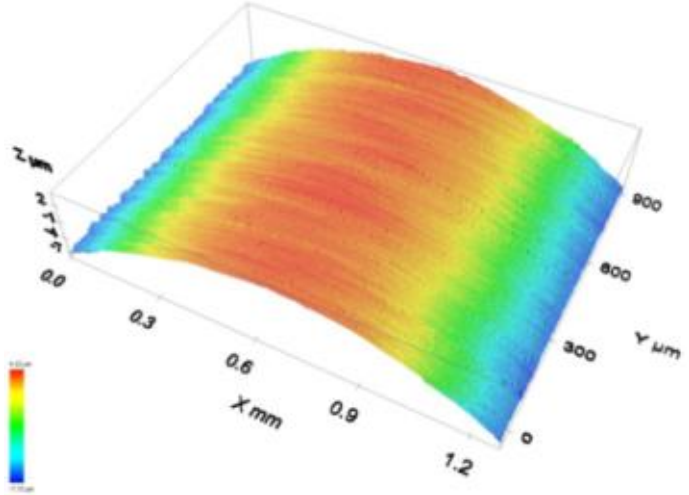
JEWELLERY AND WATCHMAKING INDUSTRY

ADDITIVE MANUFACTURING

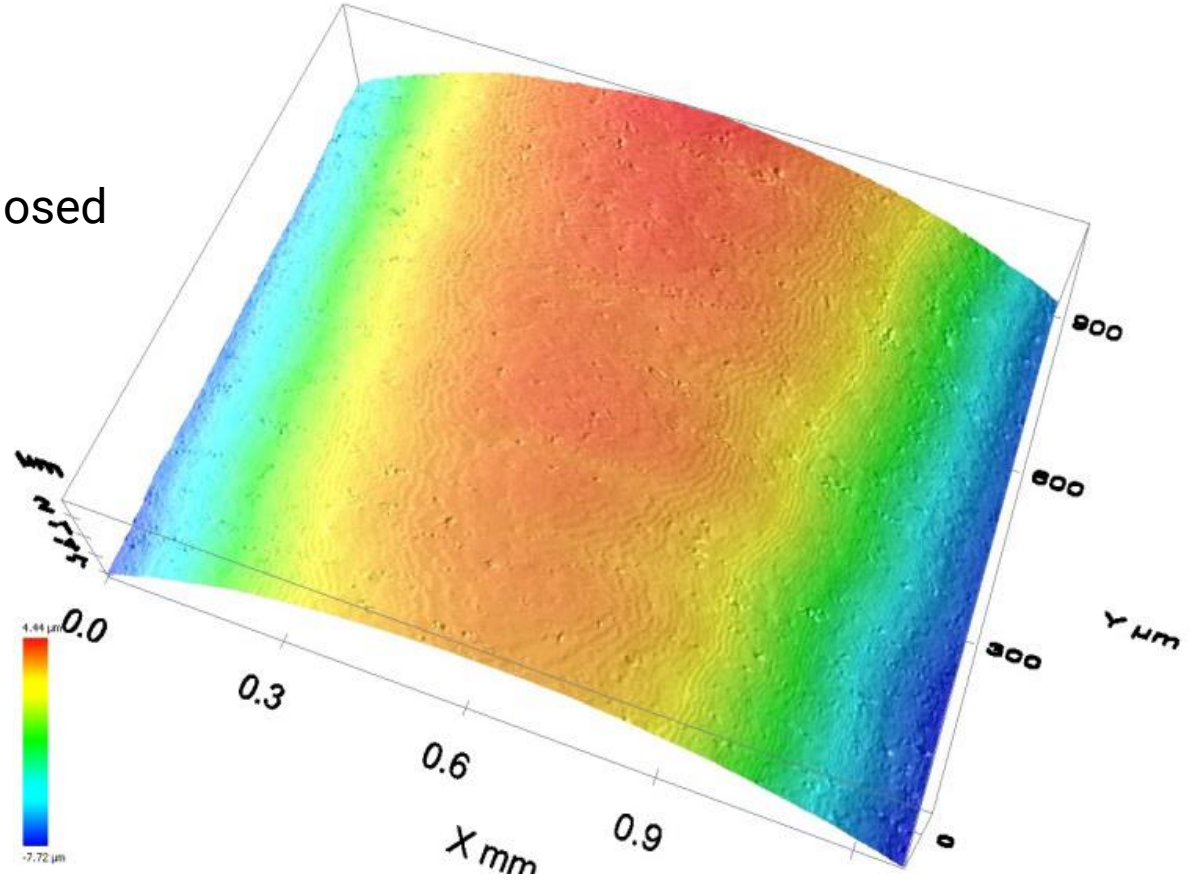
SURFACE IMPROVEMENT

TOPOGRAPHY

- Removal of grinding grooves
- Significant reduction in roughness
- Granule impact results in the formation of closed micro-cavities for an improved lubrication



Surface before Streamfinishing process



Surface after Streamfinishing process

SURFACE IMPROVEMENT

Third-body – the better Friction-surface

High frictional energy input of the process leads to:

Easy-to-shear layer:

- Impurities in the boundary layer(→AES graph)
- Only a few nm thick
- Layer is easy to deform

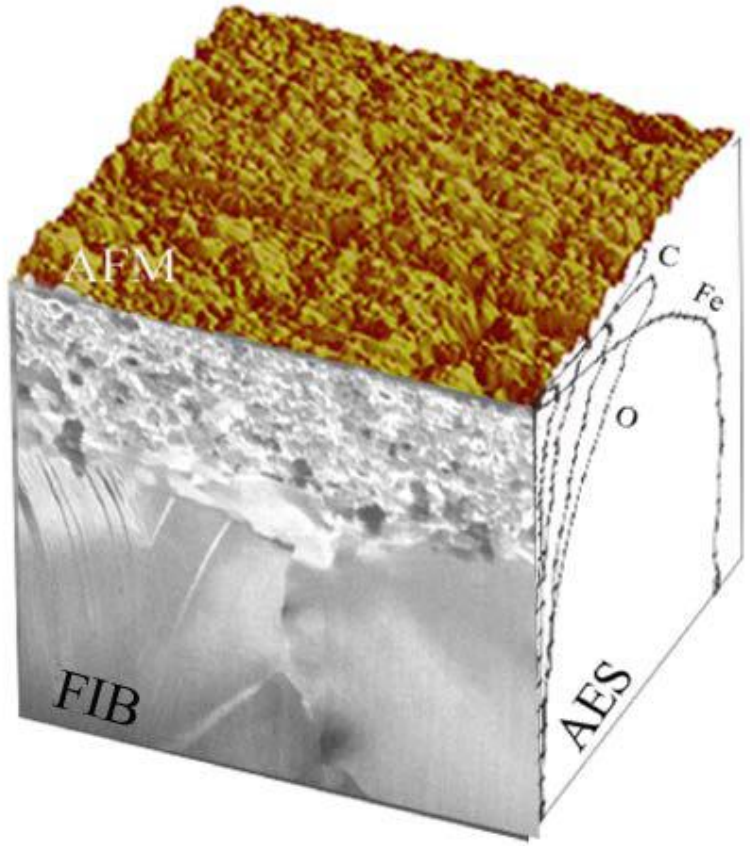
→ **Reduced coefficient of friction**

Wear resistant layer:

- Shear stress produces a nanocrystalline layer (→FIB picture)
- Increased strength, Hall-Patch-effect

→ **Reduced wear**

Third body



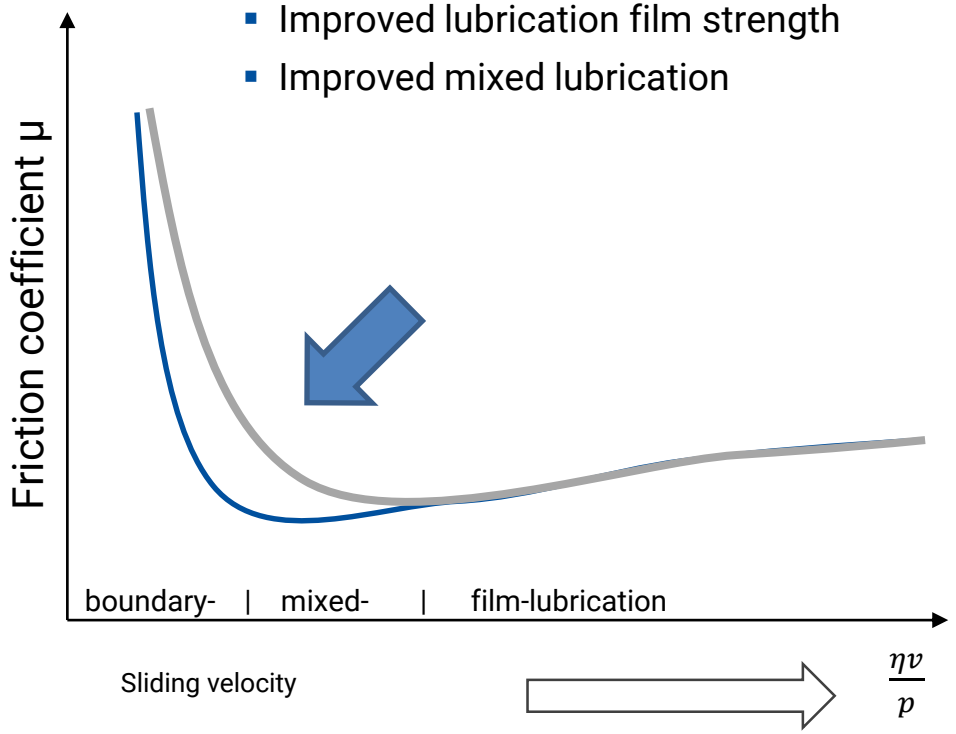
1µm - cube
source: µTC Karlsruhe

Third-body "growns" in the surface by continuingly provided friction energy – it's not lost by wear

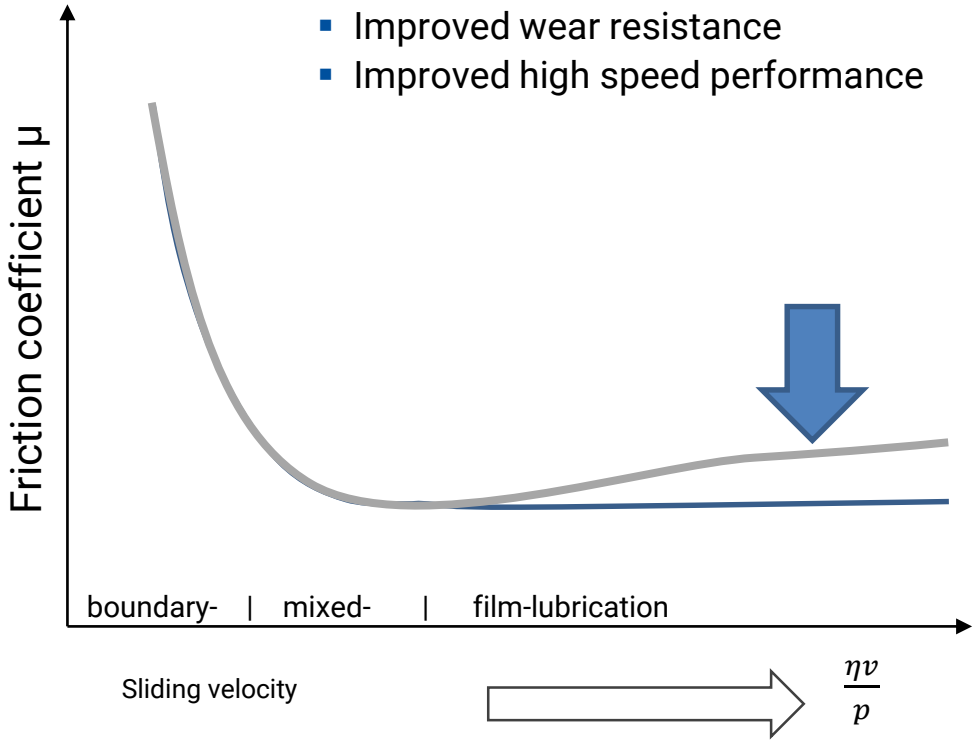
SURFACE IMPROVEMENT

Reduction of friction coefficient

- Reduced roughness peaks
- Improved lubrication film strength
- Improved mixed lubrication



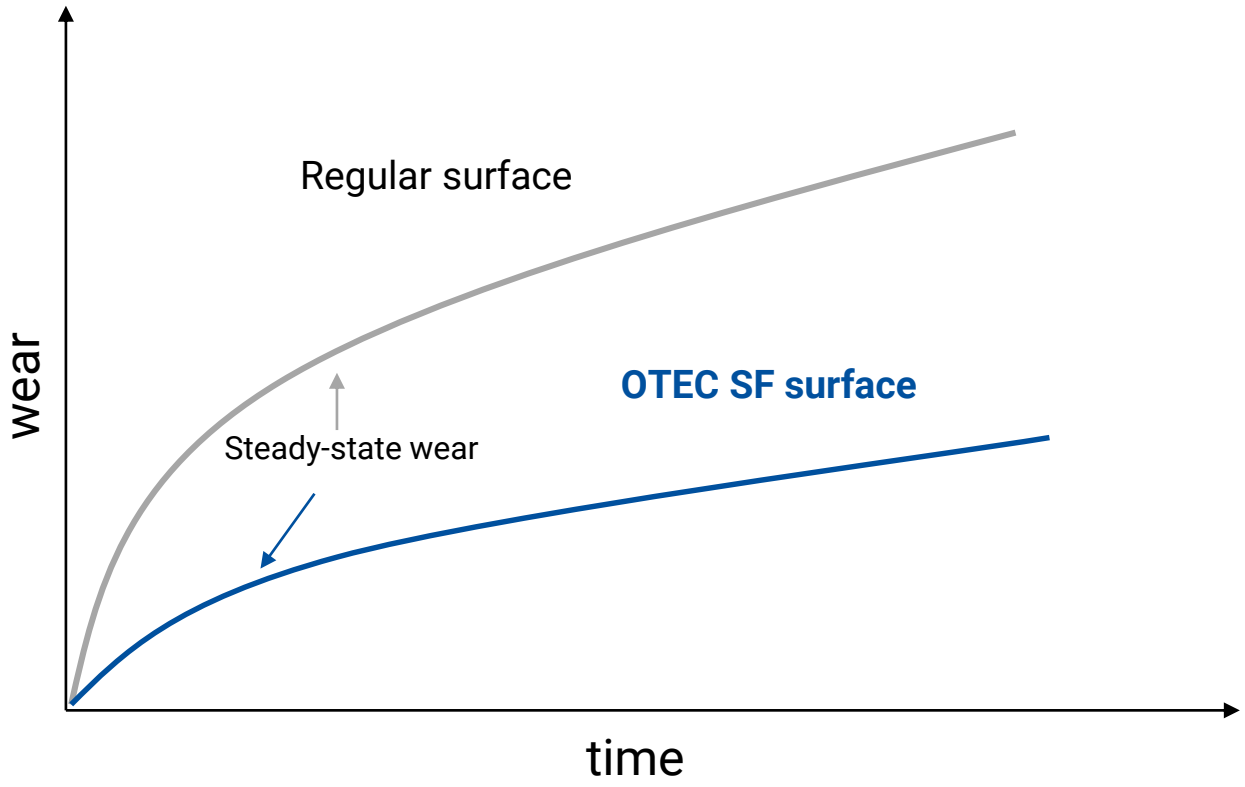
- Low viscosity oil
- Improved wear resistance
- Improved high speed performance



SURFACE IMPROVEMENT

Reduction of Wear

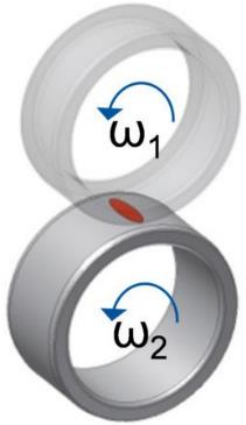
- In-manufacture running-in
  - Less wear due to *third-body*
- Stable wear corridor introduced
  - More defined, less sensitive wear window
- No running-in necessary



SURFACE IMPROVEMENT

Reduction of friction coefficient in 2-disk setup

- Friction measurement in the "2-disk rolling test" (Amsler)
- Friction value reduced by up to 30%



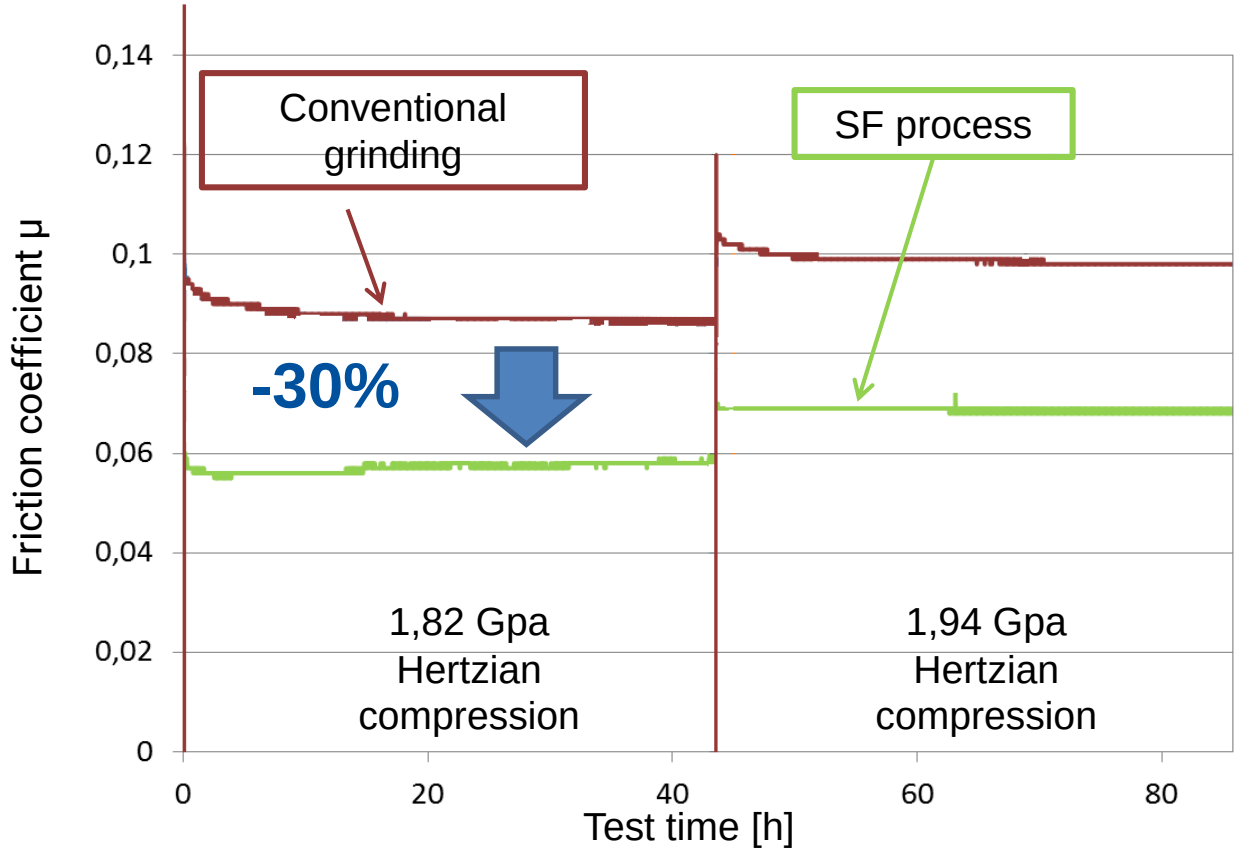
Test parameters:

Mobil SHC 624 ISO VG 32

10% Slip

1,63 m/s sum velocity

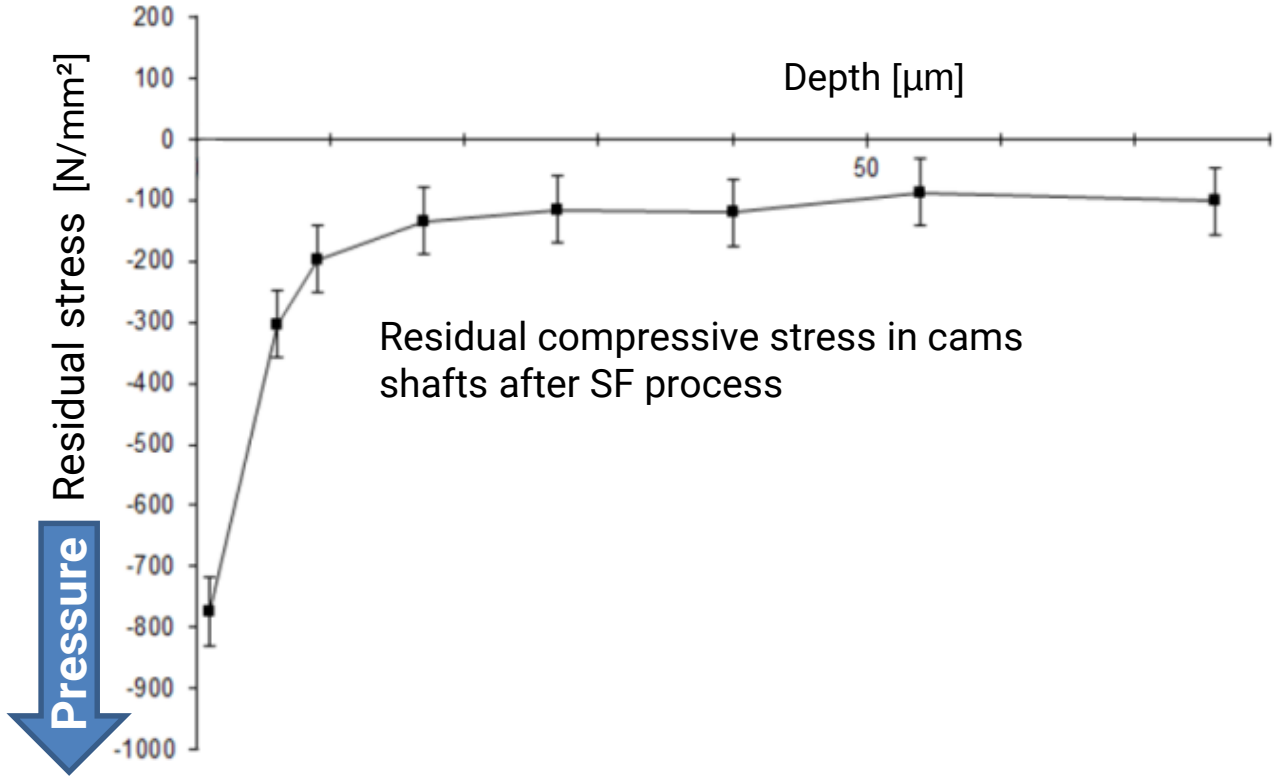
0,086 m/s sliding velocity



SURFACE IMPROVEMENT

RESIDUAL COMPRESSIVE STRESS

- SF process introduces residual compressive stress into the workpiece
- Higher resistance to bending load
- Higher bending fatigue strength
- Longer lifetime
- Lower notching effect

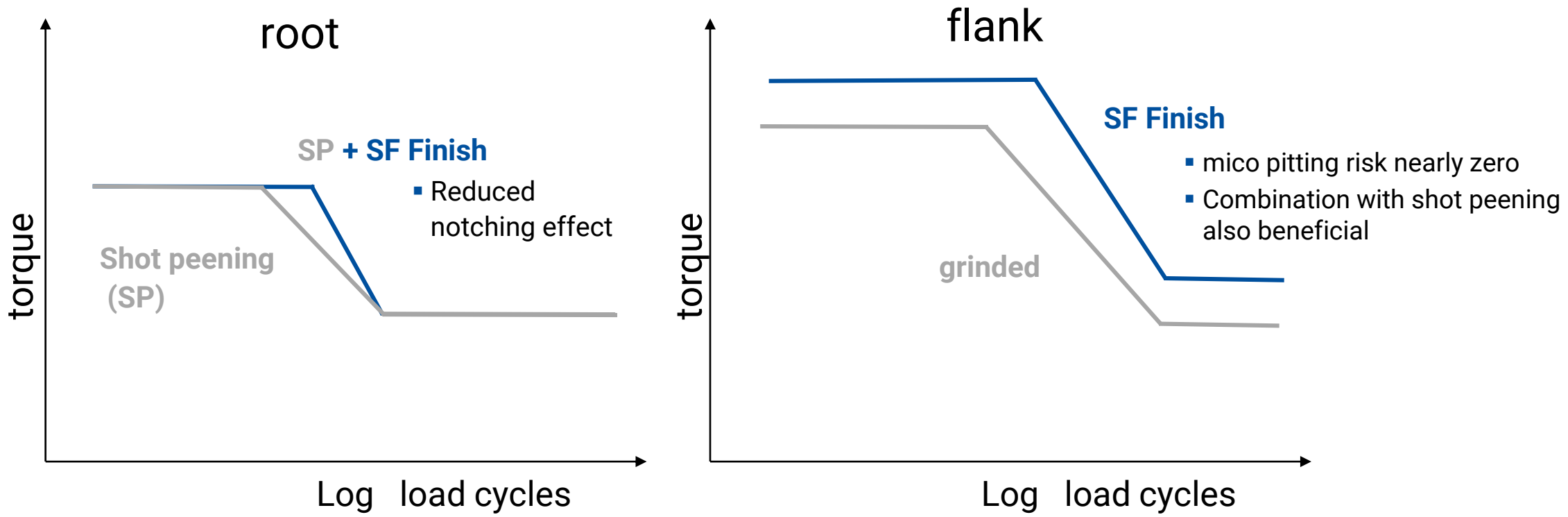


Residual compressive stress in cams shafts after SF process

SURFACE IMPROVEMENT

Improvements for gears

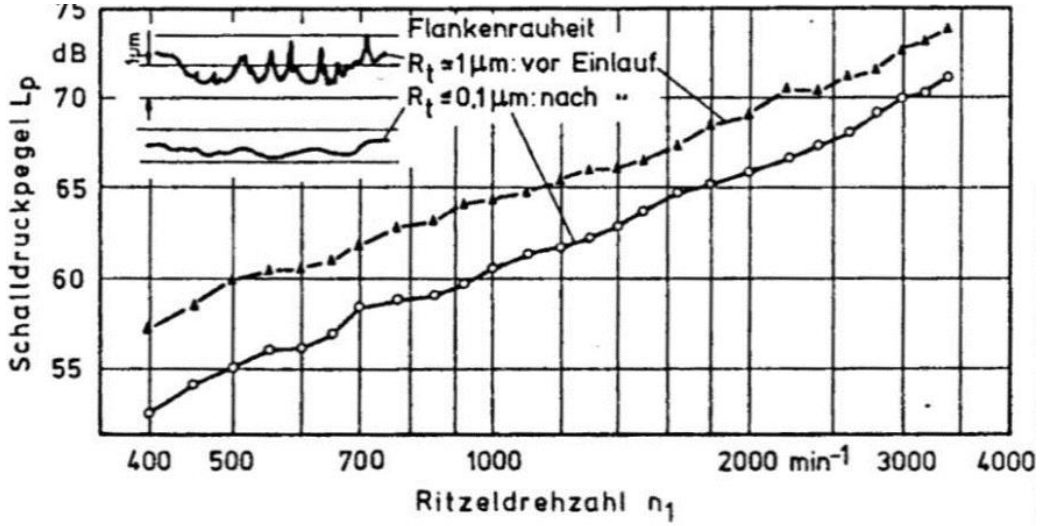
Improved durability for the root / big performance increase for flanks



SURFACE IMPROVEMENT

Improvements for gears

- Reduced roughness, reduced friction
  - Reduced noise ca. 3 dB according Niemann/Winter (on the right)
- Additional advantages
  - Improved properties for coatings e.g. DLC
  - Post-coating treatments are also possible



BENEFITS FOR CUSTOMERS

STREAMFINISH

- Higher tooth flank load capacity → Power density ↑
- Reduced friction losses → Efficiency ↑ , heat development ↓
- Use of low-viscosity oil enabled → Efficiency ↑ , heat development ↓
- Improved wear behaviour → Oil contamination ↓, lifetime ↑
- Better vibration stimulation behaviour → NHV ↓

→ **Entire improvement of component properties!**

THANK YOU FOR YOUR ATTENTION.