Minimierung von Reibung und Verschleiß mit Hochleistungskunststoffen

High Performance Polymers
Evonik Resource Efficiency GmbH

David Schmitz & Volker Strohm
Fakuma Forum – 18.10.2018
Agenda

1. Who are we?
2. Tribology – Our motivation and how we approach it
3. Development strategies
4. Application examples
5. Summary
Who we are
Evonik at a glance

- 14.4 Billion Euro sales in 2017
- >80% Of turnover gained from leading market positions
- 176 Sites
- >36,000 Employees in over 100 countries
- 2.36 billion Euro Adjusted EBITDA 2017
- ~230 New patent applications
Our structure
Strategic concentration and operative independence

Strategic Management Holding

Segments

Nutrition & Care
Products for use in the areas consumer goods, nutrition and health

Resource Efficiency
Environmentally friendly and energy-efficient systems as solutions for several industries

Performance Materials
Polymer materials and intermediates mainly for the rubber, plastics and agriculture industries

Technology & Infrastructure
Site operation, energy & utilities, technical services, logistics, process technology and engineering

2017:
5.4 Billion Euro sales
182 Million Euro R&D

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Evonik - A modern structure

Evonik

Nutrition & Care
- Personal Care
- Household Care
- Comfort & Insulation
- Interface & Performance
- Baby Care
- Health Care
- Animal Nutrition

Resource Efficiency
- Active Oxygens
- Catalysts
- Coating & Additives
- Coating & Adhesive Resins
- Crosslinkers
- High Performance Polymers
- Oil Additives
- Silanes
- Silica

Performance Materials
- Performance Intermediates
- Agrochemicals & Polymer Additives
- Functional Solutions
- Acrylic Monomers
- Acrylic Polymers
- CyPlus Technologies

Technology & Infrastructure
- Administrative Services
- Technology & Infrastructure

Corporate / Other
- Corporate Center
- Strategic R&D

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High Performance Polymers
More than 60 years experience in polymer design

Extrusion, Injection Molding, Powders, Structural Foam, Composites, Polymer Design, Additive Manufacturing, Membranes, Fibers, Polymer Specialties
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Our motivation
Use our chemical know-how to increase efficiency

Global perspective:
- In 2050: global population up to 9.5 billion
- Energy demand will increase for 70%
- Annually 5% of the GDP is lost due to friction & wear

ExxonMobil “The Outlook for Energy: A View to 2040”

Automotive & General Industries:
- Up to 30% of the energy input used to overcome friction
- Automotive: 250€ lost due to under-the-hood applications
- Short-term energy savings of around 18% are possible

Prof. Kenneth Holmberg, VTT Technical Center Finland
Interdisciplinary Task

Tribology is a system-specific characteristic

Keywords:
- lubricant
- surface
- wear
- pressure
- temperature
- sliding
- stiffness
- assembly
- impact strength
- reinforcement
- partner
- friction
- dry
- rotation
- bearing
- contact
- plastic
- gear
- alternating
- permanent
- oil
- tribologie
- elongation
- grease
- shortterm
Friction & Motion Competence Center
Since 2017 in Darmstadt

Cooperation with industry partners
Cooperation with Academia & Research Institutes
High Performance Polymers for Demanding Tribology Applications

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<tr>
<th>Bearings</th>
<th>Gears</th>
<th>Specialties</th>
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Suitable Evonik Products

- **VESTAMID®** Polyamide 12 (PA12)
- **VESTAMID® HTplus** Polyyphthalamide (PPA)
- **VESTAKEEP®** Polyether Ether Ketone (PEEK)
- **P84® NT** Polyimide (PI)
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From Screening to Component Testing

- Modelling/Screening Test
  - Mini Traction Machine / Pin on Disc

- Component Test
  - Polymer Gear Rig since September 2018 at Evonik in Darmstadt
MTM (Mini Traction Machine) Set-up

- Fundamental understanding of lubricity of materials
- Fast and flexible tribological measuring equipment
- Flexible general purpose method: frictional properties of lubricated and unlubricated contacts, wide range of rolling and sliding conditions
MTM Results at 23°C and 100°C (oil lubricated specimen)

Remark: Here we have the first series of measurements (for each case six replication)

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VESTAMID® for Steering Angle Sensor Parts

VESTAMID® gears
Interior systems

Mechatronic
Steering angle sensors

Hatchback unlocking

VESTAMID® L1930
VESTAMID® L-GF15

- Tribologically Optimized Material
- High Wear Resistance
- High Dimensional Stability
- High Ductility
- Noise Reduction
VESTAMID HTplus® for Actuator Gear Parts

VESTAMID® HTplus gears
Actuator systems, under the hood

- Tribologically Optimized Material
- High Wear Resistance
- High Temperature
- Attractive Alternative for Medium Rotation Speed
- Higher Load
VESTAKEEP® for Adblue Pumps

VESTAKEEP® gears
Safety, high load and temperature systems

VESTAKEEP® 2000 FC-30

- Tribologically Optimized Material
- Highest Temperature
- High Wear Resistance
- Highest Load
- Reduced Noise

AdBlue gear system
Steering systems
Mass balance shaft

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VESTAKEEP® for Drive Components in Wind Turbines

VESTAKEEP® gears
Safety, high load and temperature systems

Tribologically Optimized Material
Long-term Resistance
High Wear Resistance
Highest Load
Reduced Noise

Gear system
Adjustment unit
Brake system

VESTAKEEP® 2000 FC30 5000 HCM
VESTAKEEP® for Machine Elements

VESTAKEEP® gears
Actuator systems, under the hood

- Tribologically Optimized Material
- Excellent Wear Resistance
- High Temperature
- High Dimensional Stability
- Long-term Resistance

VESTAKEEP® 2000 FC-30

Bearing shell
Bearng cage
Gear wheel
Polyimide P84®NT in Automotive Parts

P84®NT parts

Gear parts, sliding bearings and functional parts close to engine

- Best Temperature Stability
- Exceptional Creep Resistance
- High Mechanical Stability
- Metal replacement
- Low CoF at high temperature

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Polyimide P84®UHT for High-Temperature Friction Applications

P84®UHT parts
Elements for high load and extreme temperature systems

- Best Thermal-Oxidative Stability
- Optimized Heat Conductivity
- High Ductility vs. graphite and ceramics
- Carbon parts replacement
- Excellent wear resistance

- Bottle grippers
- bushing
- Valve seat

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- Increasing energy demand requires efficient processes to overcome friction and wear
- Evonik approach: Generating synergies of polymer development, lubricant and surface design
- Customer Support: from screening to the application
- Overview of serial and future applications

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Nothing is perfect. There is always room for improvement.

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