5th International Conference on High Performance Plastic Gears 2023

Key topics discussed:

- Carbon footprint assessment of sustainable plastic materials
- Influence of manufacturing on gear quality and load capacity
- Recent calculation methods for load capacity and excitation behavior
- Recent test methods of plastic gears
- Optimizations of plastic gears

Presidency:

Prof. Dr.-Ing. Karsten Stahl, Full Professor, Institute of Machine Elements, Director, Gear Research Center (FZG), TUM School of Engineering and Design, Technical University of Munich, Garching, Germany

Parallel events:

- International Conference on Gears 2023
- International Conference on Gear Production 2023

Exhibition

With experts from:

Event organized by VDI Wissensforum GmbH
www.vdiconference.com/02TA409023
Phone +49 211 6214-201 • Fax +49 211 6214-154
#vdi_gears

September 13 - 15, 2023, Garching/Munich, Germany
**1st Conference day**  
**Wednesday, September 13th, 2023**

**08:15** Registration

**09:30 Plenary lectures**

- **Joint welcome and opening of the conferences**
  - International Conference on Gears 2023
  - International Conference on High Performance Plastic Gears 2023
  - International Conference on Gear Production 2023

  **Prof. Dr.-Ing. Karsten Stahl**, Full Professor, Institute of Machine Elements, Director, Gear Research Center (FZG), TUM School of Engineering and Design, Technical University of Munich, Garching, Germany

- **Welcome address**
  - a representative, TUM School of Engineering and Design, Technical University of Munich, Garching, Germany

**09:55**

- **Welcome address by**
  - Dr.-Ing. Burkhard Pinnekamp, Head of Central Technology, RENK GmbH, Augsburg; President, Research Association for Drive Technology (FVA), Frankfurt, Germany

**10:05 Keynote session:**

**Re-X: Recycle | Reuse | Reduce**

**Moderation:**

**Prof. Dr.-Ing. Karsten Stahl**, Full Professor, Institute of Machine Elements, Director, Gear Research Center (FZG), TUM School of Engineering and Design, Technical University of Munich, Garching, Germany

**Dominik Leisinger, EMBA**, Partner & Europe Lead Product Excellence (PERLab), A.T. Kearney (International) AG, Zurich, Switzerland

**The need for global standards to define CO₂ footprint in product specifications**
- High performance and low emissions is no conflict for engineering steels
- Maximum CO₂ and recycled content as properties in the steel product specifications
- Global initiatives vs sustainability demands on the product

**Erik Claesson, M. Sc.**, Director, Automotive Segment & Group Business Intelligence, Ovako AB, Hofors, Sweden

**Refurbishing tracked vehicle transmissions**
- Extended lifetime
- Upgrade and Re-use
- Increase share of re-used parts

**Dr.-Ing. Burkhard Pinnekamp**, Head of Central Technology, Sebastian Schießler, M. Eng., Head of Repair, Vehicle Mobility Solutions, RENK GmbH, Augsburg, Germany

**Increasing air travel and the challenges to reduce emissions**
- Future demand in air travel
- Emissions of air travel
- New engine architecture to reduce emission for medium and long range flights

**Dr.-Ing. David Krüger**, Design Engineer, R&T Project Manager, Transmissions, Rolls-Royce Deutschland Ltd & Co KG, Blankenfelde-Mahlow, Germany

**12:00** Time for working lunch – meet & greet in the exhibition area, poster presentation area and GearArena

**Opening of 5th International Conference on High Performance Plastic Gears 2023**

**Sustainability**

**Moderation:**

**Prof. Dr.-Ing. Karsten Stahl**, Full Professor, Institute of Machine Elements, Director, Gear Research Center (FZG), TUM School of Engineering and Design, Technical University of Munich, Garching, Germany

**13:30 Recycling of carbon fiber reinforced plastics – state of the art and challenges**

**Dipl.-Ing. Jakob Woelling**, Head of department “sustainable composites”, Fraunhofer Institute for Casting, Composites and Processing Technologies (IGCV), Augsburg, Germany

**14:00 Advanced biopolymer compounds for technical applications**

**Prof. Dr.-Ing. Katrin Wudy**, Professorship of Laser-based Additive Manufacturing, TUM School of Engineering and Design, Technical University of Munich, Garching, Germany

**14:30 Can additive manufacturing contribute to the green deal?**

**Dr.-Ing. Kevin Moser**, Group Leader, Sebastian Körber, M. Sc., Research Associate, Institute of Mechanical Engineering, Michael Geitner, M. Sc., Research Associate, Institute of Machine Elements, Gear Research Center (FZG), TUM School of Engineering and Design, Technical University of Munich, Garching, Germany

**15:00 Coffee break** – meet & greet in the exhibition area, poster presentation area and GearArena

**Tooth root strength**

**Moderation:**

**Dr.-Ing. Andreas Langheinrich**, Development Drive Technology, Horst Scholz GmbH & Co. KG, Kronach, Germany

**16:00 Prediction of tooth root fatigue failure of polymer gears for dry and oil lubricated contact and its comparison to experimentally obtained results**

**Sebastjan Matkočič, M. Sc.**, Researcher, Laboratory for Tribology and Interface Nanotechnology – TINT, Faculty of Mechanical Engineering, University of Ljubljana, Slovenia

**Efficiency-improvement with low-loss-gears by two different applications**

- Low-loss-gears for a Wolfram-transmission, reduced gear-mesh losses
- Wolfram-transmission without carrier, no losses in the radial bearings for the planets
- Low-loss-gears for a normal planetary transmission (minus-type), efficiency-improvement in a special application

**Prof. i.R. Dr.-Ing. Dr. h.c. Bernd-Robert Höhn**, TUM emeritus of excellence, Michael Geltner, M. Sc., Research Associate, Institute of Machine Elements, Gear Research Center (FZG), TUM School of Engineering and Design, Technical University of Munich, Garching, Germany

**www.vdiconference.com/02TA409023**
The conference will give you the answers to these questions:

- How can the carbon footprint of plastic gears be assessed and optimized?
- How can plastic gears be recycled?
- How can lubrication improve the performance of plastic gears?
- How can the NVH-behavior of plastic gears be evaluated and optimized?
- How does the manufacturing process impact gear performance and cost?

You are invited!
11:30 Evaluation of the NVH characteristics of gear drives with plastic gears by the forced response analysis
   • Investigation of the effect of the gear mesh damping on the NVH properties of gear drives
   • Forced response analysis of gear drives due to the transmission error excitation
   • Improvement of the NVH characteristics in gear drives with plastic gears
   Prof. Dr.-Ing. Saeed Ebrahim, Software Developer, Dr.-Ing. Ulrich Kissling, President, Sebastian Matkovic, M. Sc., Software developer, KISSsoft AG, Bubikon, Switzerland

12:00 Optimization of the vibrational behavior of crossed helical gears with a plastic wheel and a steel worm
   • FE generator with nodes in the normal section
   • Automated FE-Evaluations at different angular gear positions
   • Determination of the tooth stiffness with a plastic wheel
   Christian Kirchoff, M. Sc., Research Assistant, Chair of Industrial and Automotive Drivetrains (IFA), Faculty of Mechanical Engineering, Ruhr-University Bochum, Germany

12:30 Time for working lunch – meet & greet in the exhibition area, poster presentation area and GearArena

13:00 Manufacturing and operating properties
   Moderation: Dr.-Ing. Andreas Langheinrich, Development Drive Technology, Horst Scholz GmbH & Co. KG, Kronach, Germany

14:00 Influence of the injection molding process on the operating properties of plastic gears
   • Detailed analysis of the operating behavior using a novel gear test rig
   • Interaction of production process parameters and gear properties
   • Effect of production process induced gear properties on the operating behavior
   Christoph Herzog, M. Sc., Scientific Assistant in the field of Tribology, Institute of Polymer Technology, Friedrich-Alexander-University FAU, Erlangen, Germany

14:30 Experimental investigation on plastic gear NVH behavior
   • Plastic vibration damping properties
   • Influence of gear quality, torque, RPM, temperature, material fillers and base resin
   • Fast fourier transform analysis
   Dr. Julien Cathelin, Sr. Technical Development Engineer, SABIC Specialties, Bergen op Zoom, The Netherlands

15:00 New generation in plastic gear technologies
   • Material saving due to omitted sprues
   • Gear quality, improved radial composite deviation, tangential composite deviation, roundness of the gears
   • Cost and time saving due to omitted sprues and less optimization loops
   Dipl.-Ing. (FH) Philipp Michel, Product manager, Process Planning, Dipl.-Ing. (FH) Joseph Hackel, Head of process development, Weißer + Grieshaber GmbH, Mönchweiler, Germany

15:30 Coffee Break – meet & greet in the exhibition area, poster presentation area and GearArena

16:00 A non restrictive approach of gear geometry calculation for plastic gears
   • Introducing common kinematic calculation model
   • Surface calculation highly variable gearing geometry
   • Skewed axis planetary gear as example for disruptive thinking
   Florian Eigner, M. Sc., Development Engineer, imk Health Intelligence GmbH, Chemnitz; Univ.-Prof. Dr.-Ing. Maik Berger, Professor, Faculty Mechanical Engineering, Chemnitz University of Technology; Dipl.-Ing. Stephan Oberle, Director R&D, IMS Gear SE & Co. KGaA, Donaueschingen, Germany

16:30 Applicability of classic analytical calculation approaches for the design of plastic gears
   • Calculation of load carrying capacity of plastic gears
   • Comparison of numerical and analytical calculation approaches
   • Estimation of applicability of numerical approaches
   Markus Rothemund, M. Sc., Research Associate, Institute of Machine Elements, Gear Research Center (FZG), TUM School of Engineering and Design, Technical University of Munich, Garching, Germany

17:00 ZC-geometry in crossed helical gears – simulative studies and experimental results
   • Non-involute geometries to increase load carrying capacity
   • Design guidelines for non-involute crossed helical gears
   • Experimental results on the wear behaviour of a ZC-geometry
   Linda Becker, M. Sc., Research Assistant, Prof. Dr.-Ing. Peter Tenberge, Head, Chair of Industrial and Automotive Drivetrains (IFA), Faculty of Mechanical Engineering, Ruhr-University Bochum, Germany

17:30 Influence of the injection molding process on the operating properties of plastic gears
   • Detailed analysis of the operating behavior using a novel gear test rig
   • Interaction of production process parameters and gear properties
   • Effect of production process induced gear properties on the operating behavior
   Christoph Herzog, M. Sc., Scientific Assistant in the field of Tribology, Institute of Polymer Technology, Friedrich-Alexander-University FAU, Erlangen, Germany

18:00 End of the lectures
   - Switch to the plenary session –
   - Dinner speech by

18:45 Organized bus transfer to the evening reception

19:30 Evening reception at the ‘Löwenbräukeller’ in Munich
   You can look forward to a special evening event. We cordially invite you to our evening reception at the ‘Löwenbräukeller’ and to enjoy tradition. Enhance your personal network and use informal atmosphere for deeper-going discussions.
3rd Conference day  
Friday, September 15th, 2023

Performance and validation of plastic gears  
**Moderation:** Ingo Decker, M. Eng., Gear Development, Group Wide Components, Corporate Research & Development, ZF Friedrichshafen AG, Friedrichshafen, Germany

- **08:30** Evaluation of specialty polymer performances in gear applications and the bias between modeling and testing approaches  
  - Evaluation of ISO 102 and AMOEBA A-1133 gears performances  
  - Modeling approach to predict abrasive wear in Amoldel PPA gears  
  - Influence of part tolerances on performances

- **09:00** Experimental verification of high-performance polymer gears in an electric vehicle powertrain  
  - Use of polymer gears in applications with high power transmission  
  - Substitution of steel gears by polymer gears  
  - Experimental investigations of the load-carrying capacity under operating conditions close to those of the application

- **09:30** Influence of plastic-metal-pairings on the lifetime of gears  
  - Tooth modifications of plastic metal gear pairings  
  - Influence of gear body design on lifetime of gear meshing  
  - Validation of theoretical tooth modifications using FE-Analysis and comparing with test results

- **10:00** Coffee break – meet & greet in the exhibition area, poster presentation area and GearArena

Tribology and thermal behavior  
**Moderation:** Dr.-Ing. Marco Baccalaro, Chassis Systems Control, Gear Development and Test Conception/Realization, Robert Bosch GmbH, Heilbronn, Germany

- **11:00** Sustainability concept of high-performance polymers using the example of Polyamide12  
  - Carbon footprint reduction  
  - Alternative sources of feedstock  
  - Recycling

- **11:30** Reduction of root and flank temperature using a hybrid polymer-metal rack  
  - A hybrid polymer-metal rack is proposed  
  - A stationary test is used to validate the concept  
  - The hybrid concept decreased the flank and root temperature

Presidency  
Prof. Dr.-Ing. Karsten Stahl, Full Professor, Institute of Machine Elements, Director, Gear Research Center (FZG), TUM School of Engineering and Design, Technical University of Munich, Garching, Germany

Conference board  
Highly committed and with a great passion to succeed, the program committee – consisting of the following experts – draws up the conference agenda for you.

- **12:00** In-situ experimental methods for measuring tooth meshing displacements and wear during polymer gear tests using a high-speed camera with microscopy optics  
  - Digital image correlation method used for tooth displacement detection  
  - Newly proposed profile detection and dimensioning method used for displacement and wear analysis  
  - Displacements and wear can be measured across entire tooth profile

- **12:30** Closing remarks

- **12:45** Awarding of the best presentation for young engineers by the conference president
  **Prof. Dr.-Ing. Karsten Stahl,** Gear Research Center (FZG), TUM School of Engineering and Design, Technical University of Munich, Garching, Germany

- **13:00** Awarding of the best paper by  
  **Dr.-Ing. Franz Völkel,** Sr. Vice President R&D Bearings, Schaeffler Technologies AG & Co. KG, Herzogenaurach, Germany

- **14:15** End of the conference

Scientific support:  
**VDI Society Product and Process Design**  
The VDI SOCIETY PRODUCT AND PROCESS DESIGN (VDI-GPP) and its technical divisions provide all sectors with verified knowledge on the design of products and processes and their optimization in terms of quality and the time- and cost-benefit ratio.

**www.vdi.eu**
Gears interactive – new ideas, more added value for your business

**GearArena**

Gather hands-on experience in the transmission world!
Take a look at individual gear components, gain an insight into how the different components interact and compare design and workmanship! You will find an on-site contact person from the exhibitor to answer all your questions.

**FZG lab tours**

Get the chance to visit innovative laboratory facilities!
Seize the opportunity and visit the nearby test and laboratory facilities at the Gear Research Center (FZG). Several guided tours with different core topics offer opportunities of gaining deeper insights into a variety of innovative gear test rigs and laboratory equipment. For registration meet at the FZG information desk during the conference.

**Speakers meetup**

Do you still have unresolved questions?
You can address your questions to the speakers right after the lecture during the coffee break. Take the chance to say hello to your favorite speakers and to connect with them. They will be available for at least 15 minutes after their session.

**Poster exhibition with impulse talks**

The poster exhibition is combined with a 5-minute talk.
The compact style of presentation called the ‘5-minute rapid’ presentation, will provide you with all information in a clear, succinct manner. Poster presentations are scheduled during the coffee breaks. Presentation times will be announced on-site.

**Two gear community nights**

Your networking hotspot for the international gear community!
Enjoy the evening reception at the ‘Löwenbräukeller’ as well as another social event at the university. The ‘Löwenbräukeller’ is a restaurant with a long tradition offering modern Bavarian cuisine. Both – the get-together at the FZG and the brewery visit – offer you an excellent opportunity to network with your peers and catch up on trends.

**Venue:**

Source: Scharger, Albert/TUM
Parallel conferences

International Conference on Gears 2023
September 13 - 15, 2023, Garching/Munich, Germany

Key topics:
- Sustainable gears with reduced carbon footprint and increased efficiency
- Optimization of gear design and geometry
- New test methods for endurance, efficiency and NVH behavior
- Numerical methods and multiscale simulation tools to improve gear performance
- Smart gears for condition monitoring systems and additional functions
- Life cycle assessment of geared drive systems

President:
Prof. Dr.-Ing. Karsten Stahl, Full Professor, Institute of Machine Elements, Director, Gear Research Center (FZG), TUM School of Engineering and Design, Technical University of Munich, Garching, Germany
Dr.-Ing. Bernhard Bouché, Director of Research and Development Mechanics, Getriebebau NORD GmbH & Co. KG, Bargteheide, Germany
Prof. i.R. Dr.-Ing. Dr. h.c. Bernd-Robert Höhn, TUM emeritus of excellence, Gear Research Center (FZG), TUM School of Engineering and Design, Technical University of Munich, Garching, Germany
Dr.-Ing. Burkhard Pinnekamp, Head of Central Technology, RENK GmbH, Augsburg; President, Research Association for Drive Technology (FVA), Frankfurt, Germany

Further details and the final program can be found here:
www.vdi-gears.eu

Parallel conferences

5th International Conference on Gear Production 2023
September 13 - 15, 2023, Garching/Munich, Germany

Key topics:
- Sustainable gear production
- Inline quality inspection for gear production
- Additive manufacturing of gears
- Performance of new gear materials in gear manufacturing
- Hard finishing of high performance gears
- Innovative processes for gear manufacturing

President:
Prof. Dr.-Ing. Thomas Bergs, Full Professor, Laboratory for Machine Tools and Production Engineering (WZL), Chair for Manufacturing Technology, Faculty for Mechanical Engineering, RWTH Aachen University, Germany
Prof. Dr.-Ing. Christian Brecher, Full Professor, Chair of Machine Tools, Laboratory for Machine Tools and Production Engineering (WZL), Faculty for Mechanical Engineering, RWTH Aachen University, Germany
Prof. Dr.-Ing. Karsten Stahl, Full Professor, Institute of Machine Elements, Director, Gear Research Center (FZG), TUM School of Engineering and Design, Technical University of Munich, Garching, Germany

Further details and the final program can be found here:
www.vdi-wissensforum.de/02TA411023

Exhibition & sponsorship

As an exhibitor or sponsor you can position your company with a clearly perceptible presence within a selected circle of participants. Get in contact with top-class attendees at this conference and present your products and services to a specialist audience in your market without any coverage waste.

- AVL Deutschland GmbH
- DuPont Delrin(R) Switzerland Sarl
- Evonik Industries AG
- Framo Morat GmbH & Co. KG
- GEORGII KOBOLD GmbH & Co. KG
- Horst Scholz GmbH & Co. KG
- IMS Gear SE & Co. KGaA
- KiSSsoft AG
- MESYS AG
- MS-Schramberg GmbH & Co. KG
- Schaeffler Digital Solutions GmbH
- Smart Manufacturing Technology Ltd., UK
- Stagnoli T.G. S.r.l.
- Telemetrie Elektronik GmbH
- Weißer und Griebhaber GmbH
- Winkelmann Flowforming
- NGC
- AVL
- DuPont
- Evonik
- Framo Morat
- GEORGII KOBOLD
- Horst Scholz
- IMS Gear SE & Co. KGaA
- KiSSsoft AG
- MESYS AG
- MS-Schramberg
- Schaeffler Digital Solutions
- Smart Manufacturing Technology Ltd., UK
- Stagnoli T.G. S.r.l.
- Telemetrie Elektronik GmbH
- Weißer und Griebhaber GmbH
- Winkelmann Flowforming

Your contact person:
Vanessa Ulbrich
Phone: +49 211 6214-918
Email: ulbrich@vdi.de
Please register for (price per person plus VAT):

<table>
<thead>
<tr>
<th>5th International Conference on High Performance Plastic Gears 2023</th>
</tr>
</thead>
<tbody>
<tr>
<td>September 13–15, 2023, Garching near Munich, Germany</td>
</tr>
<tr>
<td>(02TA409023)</td>
</tr>
<tr>
<td>EUR 1,690.–</td>
</tr>
</tbody>
</table>

- Participation fee for personal VDI members and members of associated organisations of the International Conference on Gears 2023 save EUR 50,- each conference day
- VDI membership no.*:___________________
  * For price category 2, please state your VDI membership number or the name of the associated organisation (outlined at the homepage www.vdi-gears.eu)
- I'm interested in sponsoring and/or the exhibition

Please register for (price per person plus VAT):

<table>
<thead>
<tr>
<th>First Name</th>
<th>Last Name (Family Name)</th>
<th>Title</th>
<th>VAT-ID</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Company/Institute</th>
<th>Job Title</th>
<th>Department</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Street</th>
<th>ZIP Code, City, Country</th>
<th>Phone</th>
<th>Email</th>
<th>Fax</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Deviating bill address

Participants with an invoice address outside of Austria, Germany and Switzerland are kindly requested to pay by credit card. Please don’t send your credit card details via email, fax or post. Please book your ticket at www.vdiconference.com/02TA409023. Transferring your credit card details via our website ensures your details are encrypted and security of your data is guaranteed.

Data protection: VDI Wissensforum GmbH uses the email address you have provided to regularly inform you about similar VDI Wissensforum GmbH events. If you no longer wish to receive any information or offers, you can object to your data being used for this purpose at any time. To do so, use the following email address wissensforum@vdi.de or one of the other contact possibilities mentioned above.

We would like to make you aware of general information about the usage of your data here: https://www.vdi-wissensforum.de/en/privacy-policy/;

More hotels close to the conference venue may be found via our HRS service, www.vdi-wissensforum.de/hrs.

Information: The price includes conference documents (e-book), coffee breaks and beverages during breaks, lunches and two evening receptions.

Exclusion offer: All participants at this event are entitled to a free three-month trial VDI membership. Offer applies exclusively to new members.

Methods for simulation and calculation of plastic gears

You need help? Please contact us!

VDI Wissensforum GmbH
P.O. Box 10 11 39
40002 Düsseldorf, Germany
Phone: +49 211 6214–201
Fax: +49 211 6214–154
Email: wissensforum@vdi.de
www.vdiconference.com/02TA409023