Chair of Metal Forming and Casting
TUM School of Engineering and Design
Technical University of Munich

utg Newsletter Issue 10 06/2024

Chair of Metal Forming and Casting

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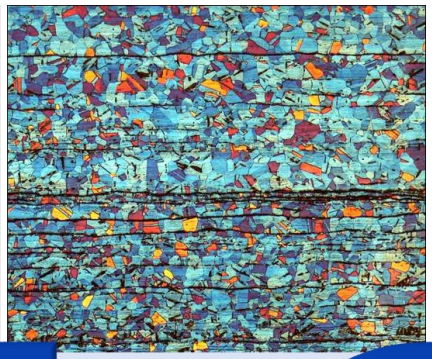

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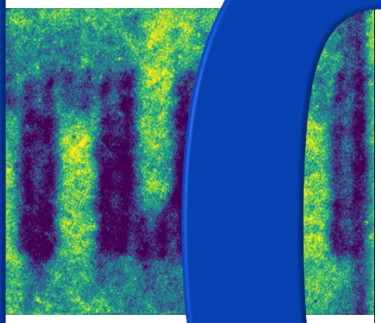

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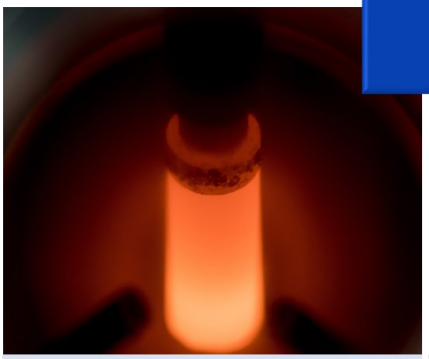

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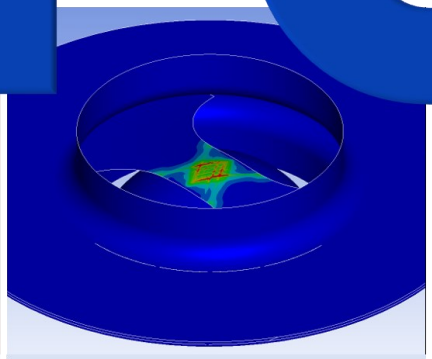

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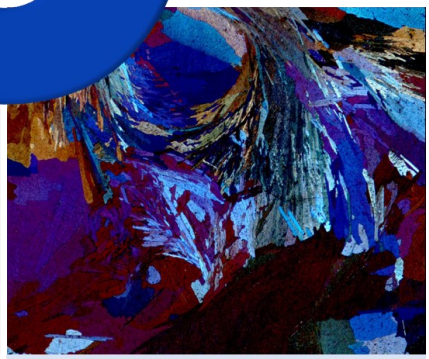

utg Newsletter 12/2023

If you want something, you find ways.
Those who don't want something will find reasons."

Popular saying

Editorial

Dear friends and partner,

It is with great pleasure that I present to you our new newsletter about the Chair. This time it's even an anniversary edition. Our newsletter has been around since 2019 and you are now looking at the 10th issue. Of course, we believe this should be celebrated accordingly. I would therefore like to draw your attention to the upcoming dates:

The first highlight is our traditional **in-house exhibition on July 18** from 4 pm. With the hope of beautiful summer weather, I would ask you to make a note of this important date for the whole utg family and friends and I would encourage you to register. In the meantime, we also have enough registrations for the Alumni Day, so that I would also like to recommend this opportunity for all alumni of the chair to get together from noon on July 18. But that's not all.

We also have a lot planned for September: On **September 11-12**, we are hosting the **Forming Technology Forum-FTF** in Ohlstadt in the beautiful Bavarian Oberland. On the subject of “All About Blanking”, we have 20 exciting international presentations on offer for this traditional conference with a classic utg theme. Take a look at the link provided.

One week later, on **September 17**, 2024, we will be hosting a **user meeting on freeform bending** for the first time. This has been a research focus of our forming group for many years now, and we would like to share with you the many research results and practical experiences we have gained in the field of free-form bending.

With our participation in the **open day** on **October 3**, 2024 at the Garching research campus, we are also showing our research facility to a broad public from young to old.

Last but not least: On **November 28**, we are once again inviting you to the traditional **Bavarian Barbara Conference** at the Fraunhofer IGCV.

You can find all the information about the various events on pages 11 and 12 of this newsletter.

Prof. Dr.-Ing. Wolfram Volk *Photo: Heddergott/TUM*

I look forward to meeting you in person on at least one occasion.

I hope you enjoy reading our anniversary newsletter.

Wolfram Volk and the whole *utg* team

utg News

New Press in Our Machine Pool

In February 2024, we welcomed the latest addition to our machine and plant fleet at utg: a completely overhauled BSTA 50 - 110 automatic punching press.

The machine underwent a comprehensive retrofit at Bruderer GmbH in Dortmund. In addition to its robust mechanics, it now also boasts a modern B2 control system and a reliable BSV feed. Together, these features guarantee the characteristic maximum precision.

The manual adjustment stroke allows stroke heights from 16 to 51 mm with stroke rates of up to 1120 strokes/min. Bruderer automatic punching presses are an essential part of our teaching and research activities. Particularly in the cutting and punching technology research group, modern production systems such as the BSTA 50 - 110 enable industry-oriented and excellent research.

In addition to service life tests and studies on the subject of electrical sheet processing, the research projects running on the machine also include the characterization of forming machines through the dynamic measurement of high-speed presses.

The new automatic punching press is the perfect addition to the existing BSTA 1600 - 181 punching presses and is also closely integrated into teaching operations, inspiring Bachelor's and Master's students in the course of lectures, internships and student research projects.

Bruderer punching press BSTA 50 - 110 (left) and BSTA 1600 - 181 (right), Photo: utg

We would like to take this opportunity to thank Bruderer GmbH Dortmund and Bruderer AG Switzerland for their many years of excellent cooperation.

Foundry Technology Conference in Salzburg

Gießereitechnik München was well represented **at the Großen Gießereitechnischen Tagung 2024** in Salzburg. Every four years, German-speaking foundry research meets in Salzburg, a conference city close to the border. This year's event focused on sustainability and upcoming transformations in the industry towards a **future with casting**! On the one hand, this transformation in an admittedly uncertain industrial environment in Germany can be lamented; on the other hand, this enviable opportunity to secure our prosperity with innovative cast products from Europe will take us much further, as was made clear in the keynote speech by futurologist Franz Kühmayer.

Simon Kammerloher from the utg also spoke about the **gas formation of sustainable inorganic cores** during the casting process. He presented the new analysis furnace developed at the chair. Inductive heating is used to precisely determine the time of the resulting gas shock in a controlled test environment. The advantage of this arrangement lies in the simple provision of measurement data from different sand-binder systems, which in turn enable modeling. This enables virtual validation through simulations for real component geometries.

The presentation by **Max Schütze** from Aalen University also attracted further attention. In a joint DFG project with the *utg* chair, research is being carried out on **inorganic cores for die casting**. The aim here is to develop a multi-layer core that has sufficient strength in the casting process and yet can be mechanically decored. This conflict of objectives is to be resolved with differently adjusted sand-binder mixtures.

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In addition to the presentations, there was also a little time to enjoy the beauty of Salzburg.

Erwin Reberger, Julika Hoyer and Simon Kammerloher represented the utg at the GGT Salzburg 2024, Photo: utg

Giessereitechnik München would like to thank the German-speaking umbrella organizations of the foundry industry for the successful organization of the event.

14th Stamping Technology Congress

The traditional meeting of the stamping technology industry on April 8 and 9 at the Westfalenhallen Congress Center in Dortmund offered exciting presentations and opportunities for personal and professional exchange. Numerous **specialist presentations** on the topics of *green production*, *connected processes* and intelligent *tool concepts* addressed the latest trends in stamping technology and were followed by lively discussions among the participants.
In the **panel discussion** moderated by Wolfram Volk on *Green Production - In the area of conflict between political targets and real production requirements*, the challenges and opportunities for the stamping technology industry were discussed. Various players from the stamping technology industry were represented on the panel:
Thomas Stäuble, SWD AG
Dr.-Ing. Philipp Sinn, SINN Power GmbH
Markus Schnöll, Otto Bihler Maschinenfabrik GmbH & Co. KG
Dr. Winfried Blümel, Feintool System Parts Obertshausen GmbH
Dr. Hanni Koch, VIA Consult GmbH & Co. KG
Markus Schaltegger, Qcision
Dr. Katrin Meier, BMW Group

The accompanying trade exhibition offered all participants the opportunity for personal exchange in order to maintain existing contacts, but also to make new ones.

The many interested listeners at this year's Stamping Technology Congress were offered many exciting presentations on topics relevant to the future, Photo: utg

The organizers of the KIST e.V. congress and the Chair of Forming Technology and Foundry Engineering were once again delighted with the continued high level of interest from the industry this year, with over 200 participants.
We are already looking forward to the 15th Congress on Stamping Technology on April 7 and 8, 2025.

utg News

SPP 2013 Sucessfully Finished

After more than six years, the research results of the SPP 2013 on *the targeted use of forming-induced residual stresses* have now been published. Wolfram Volk, coordinator and spokesperson, presented the final report.
Since autumn 2017, 24 research institutes from 12 universities have been working together in 12 different projects on the use of residual stresses in metallic components. A total of 167 scientific publications, 11 illustrative project videos and a lecture series on residual stresses for bachelor's degree courses were produced during this time.
In SPP 2013, residual stresses were controlled and monitored by sheet metal or solid forming in such a way that they have a positive effect on properties that are later relevant in component use. These include, for example, fatigue strength, static strength and buckling stiffness and strength in combination with property stability during operation.

Fall 2017: The SPP2013 launched its six years of joint research with a kick-off meeting in Garching, Photo: utg

Further information and all publications relating to SPP2013 can be found on our website.
The knowledge gained in the various projects has been incorporated into ongoing transfer projects. A key component here is the active involvement of application partners from industry. Six such knowledge transfer projects were approved by the DFG.

Girls' Day 2024 - our doors were open!

On 25.04.24, as part of this year's girls' day, we were once again able to welcome some young girls to our department. We used the annual nationwide career orientation day to introduce the schoolgirls to the exciting world of technology, science and innovation.
The day started with an overview of the day's program and a short presentation on how a cast component is created, from design to simulation to mold production,

The girls of 2024 together with Christoph and Tanja, Photo: utg

casting and demolding. The theoretical knowledge was then immediately put into practice in the in the utg hall. Together, an owl casting model was molded in sand and then cast. The cooling time was used to see the chair's presses and liquid metal jetting in action and to take a look at the microstructure of a metal part using a

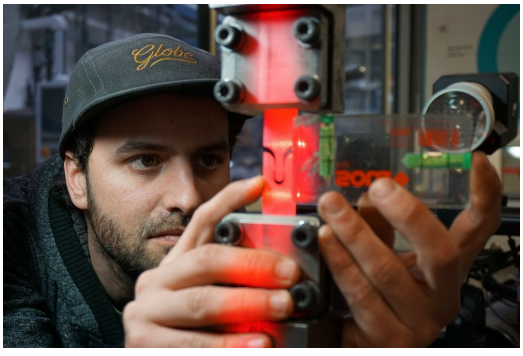
utg News

microscope. After a short refreshment and a small foosball game on the self-built utg foosball table, we continued to the Fraunhofer IGCV with our own aluminum owl in our luggage. There they were given an insight into how components are designed with the help of CAD programs. At the Particle Analyzer they were allowed to give tips on how many grains of sand are in a tube and then experience how the device counts these grains. A short lecture on the importance of computer simulation in foundry work and the 3D printing of small, personalized heart pendants concluded the day.
We hope the girls had as much fun as we did. We are already looking forward to Girls' Day 2025.

utg PhD program **SciWay**

The SciWay at the *utg* enables ambitious students to immerse themselves in the world of doctoral studies at an early stage and gain a unique academic qualification.

By participating in the SciWay program, Master's students interested in research are given the opportunity to combine their Master's and doctoral studies and work towards a doctorate at the same time.



In addition to exciting insights into cutting-edge research, we offer

- **Mentoring** by experienced colleagues
- **Further training** by attending trade fairs and conferences
- **Team spirit** with games, fun and sport

For more information, visit our website or write to sciway.utg@ed.tum.de

We accept applications throughout the semester.

New SPP 2476 at *utg*

In March, the DFG decided to establish the SPP 2476 "**Cross-Process Modeling in Production Engineering**" with Wolfram Volk as coordinator.

The call for research projects has now been published and the application phase for the first of the two three-year funding periods has begun!

As coordinators, we invite you to apply with an exciting research project.

The application deadline is September 15, 2024.

You can find the details of the call for proposals on the DFG homepage or at our website.

Current Research at *utg*

Casting

New Process Route for the Production of Aluminum Copper compounds

Motivation

Good electrical conductivity and low weight are a great advantage for many components. Here, the combination of two different materials can help to improve the desired product properties. One particularly interesting combination in this respect is aluminum-copper composite semi-finished products. Until now, however, the process route using cold roll cladding has required several process steps in order to achieve the necessary composite strength.

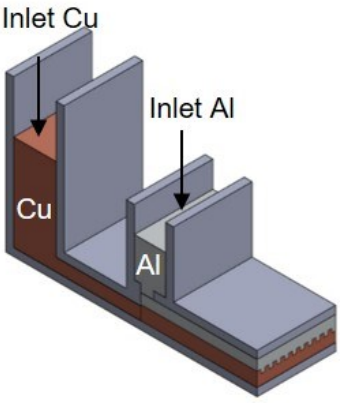
Reducing the process route to a continuous composite casting process with subsequent finish rolling, on the other hand, enables production close to the final dimensions and at low cost.

The formation of intermetallic phases in the bonding zone in the continuous casting process already begins with the first contact of the liquid aluminum with the copper strand. The increased temperatures in the process also promote the formation.

A high surface enlargement is necessary for the subsequent rolling process so that the brittle phases can break open and the base materials can come into contact for a material bond. Up to now, this has resulted in disruptive delamination between the bonding partners during the process, as high shear stresses occur in the bonding zone.

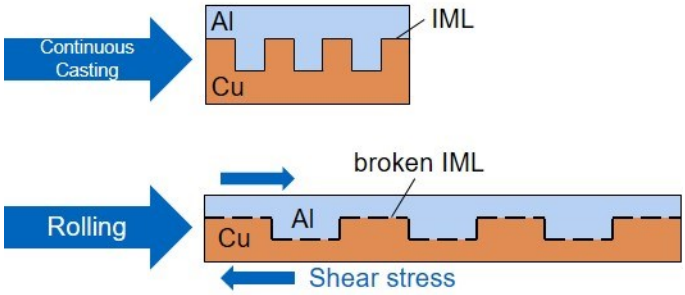
Solution Approach

Our current research project, funded by the DFG - 457434681, focuses on the composite continuous casting process route with subsequent finish rolling. Together with the Institute for Forming (ibf) at RWTH Aachen University, utg is researching the realization of the new process route. Due to the pronounced intermetallic phase formation in the bonding zone and the resulting delamination in the rolling process, the process has not yet been used industrially. In order to realize the economically interesting process route nevertheless, a geometrically pronounced interface is to be introduced into the composite zone by means of a structured sliding mould. This geometric constraint can prevent relative movements between the bonding partners and thus reduce undesirable shear stresses. The increase in surface area during rolling can thus be realized without the bond partners shearing off.



Procedure

In order to investigate the solidification conditions at the interface, different mold geometries are investigated experimentally and simulatively. Therefore, a special mold is designed to get the desired shape. The geometric design of the interface influences both the process stability and the effectiveness in avoiding shear stresses and thus the bond strength of the final product. Due to the pronounced solidification shrinkage during casting, shrinkage effects on the mold profiles are taken into account. The geometry in the bonding zone also influences the ability to compensate for shear stresses occurring during the rolling process.



Finally, the results are used to expand the portfolio of geometries produced by continuous casting to include profiled surfaces and to enable the production of aluminum-copper composite semi-finished products.

Contact: Julika Hoyer, M.Sc.

Current Research at *utg*

Cutting and Blanking Technology

Embossed Flux Barriers for Efficient Electric Motors

Motivation

The advancing climate change requires efficient and resource-saving drive systems. In the mobility sector, electric drives are a core technology in dealing with these requirements. Increasing the efficiency of electrical machines can therefore help to reduce emissions in this sector. Due to its ferromagnetic properties, iron-silicon-based electrical steel stacked in thin laminations forms the magnetic core of electrical machines and is therefore crucial to their efficiency.

Compromises in the rotor: mechanical strength and flux guidance

Modern electrical synchronous machines place high demands on the guidance of the magnetic flux in the rotor and stator laminations. These non-grain orientated electrical laminations are typically produced by shear cutting and then packaged. A strong magnetic coupling between the rotor and stator is essential for a high torque density. Particularly in permanent magnet synchronous machines (PMSM) and synchronous reluctance machines (SynRM), a high magnetic anisotropy of the rotor is necessary to generate the torque. This anisotropy is conventionally generated via shear-cut recesses, so-called flux barriers. However, these flux barriers lead to a mechanical weakening of the rotor, as the centrifugal forces of the rotor then act completely on the remaining thin webs.

Targeted use of forming induced residual stress for flux guidance

Previous studies by the consortium of the Technical University of Munich and RWTH Aachen University have already shown that the targeted introduction of residual stresses by embossing is suitable for creating flow barriers. The local reduction in permeability, i.e. the strength of the flow barrier, depends on process parameters such as the embossing geometry, embossing pattern and embossing force. The comparison of embossed and conventionally shear-cut flux barriers showed similar magnetic properties. At the same time, a considerable increase in mechanical strength was achieved by replacing cut-outs with embossed flux barriers.

From laboratory scale to application in the series rotor

The aim of this research project is to transfer the findings of the previous project phases to the application of a series rotor. This is being done together with the industrial partner Mubea. To this end, a series rotor is first replicated with a reference material and then its geometry is further developed with embossed flow bars on this basis. According to the research hypothesis, this innovative rotor will then have a comparable magnetic coupling between the rotor and stator with the same dimensions but will have increased mechanical strength and therefore a higher maximum permissible speed and consequently an increased energy density

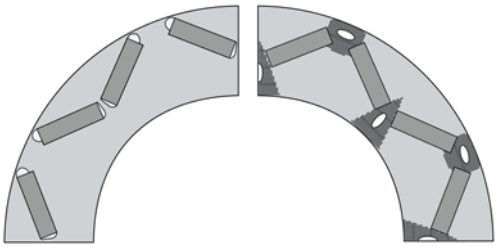


Figure 1: Schematic representation of the innovation approach. Conventional flow barriers are replaced by similar but smaller recesses with embossed flow barriers.

Contact: Phillip Stöcks, M.Sc.

Current Research at *utg*

Forming Technology

Hydrogen pressure vessels - Manufacturing, material behavior and damage

Initial situation and targets

The aerospace and heavy goods transport sectors are dependent on alternative energy sources such as hydrogen for the energy transition. To compensate for the low volumetric energy density of H2, high pressure and extremely low temperatures are used. However, this results in high thermomechanical loads on the pressure tank.

Several research projects are currently underway at the utg to investigate these loads scientifically. These include the production of large-volume pressure tanks, the material behavior and the permeability or damage under realistic conditions.

The results should help to further develop hydrogen storage technology and make it safe for commercial use.

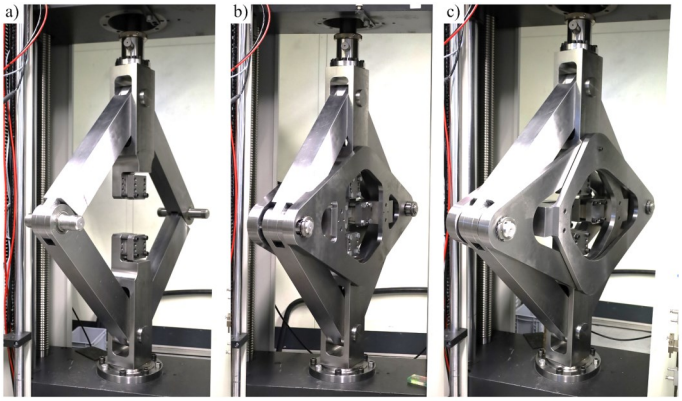
Solution Approach

The production of large-volume storage tanks is still a major challenge. In particular, the seamless production of the often used metallic inner skin, also known as a liner, is difficult. The utg is therefore working on the development of a new production technology for such liners, which is based on hydroforming.
hydroforming (IHU).

The hydroforming process offers several advantages over the incremental process often used today: The usual production of a hollow body from a blank can be omitted. Instead, tubes are used as semi-finished products and formed. In addition, the so-called bottle neck is a critical point. This is usually produced by incrementally tapering or drawing in the ends. By expanding the pipes using the hydroforming process, this process starts from a smaller diameter at the ends, which saves time and resources. The utg supports this development by simulating the production route and conducting experimental studies.

The material behavior of the liners during production and operation is also the subject of the investigations. In the aerospace industry, on the other hand, a metallic shell is not used in order to further reduce weight. The problem with these tanks made of pure carbon fiber reinforced plastics (CFRP) is their impermeability. The high thermo-mechanical loads lead to cracks in the composite material, which can combine to form crack networks and thus lead to leaks.

In order to better understand this effect, a testing device was developed at the chair that allows permeation testing of cross-tensile samples under realistic conditions. Specifically, this means that the samples are subjected to a multi-axial stress state during the measurement and simultaneously cooled to cryogenic temperatures using liquid nitrogen.



Test device for multiaxial strain conditions
a) base; b) plane strain; c) biaxial strain, photo: utg

Outlook

The further development of sustainable storage technologies is essential for the successful transformation of our economy and society. The development and elaboration of possible production routes is crucial in order to enable the economically and technically viable production of pressurized hydrogen containers. It is also essential to consider the material behavior under the prevailing extreme conditions in order to enable the safe use of these technologies.

Our findings thus contribute to the successful further development of hydrogen storage technology and the commercial utilization of hydrogen as an energy carrier, particularly in cooperation with industrial partners.

Contact: Edgar Marker, M.Sc.
For further information visit the website.

Events at *utg*

July 18, 2024

Inhouse Fair „Summer at *utg*“

We cordially invite you to our traditional in-house exhibition! In addition to many interesting discussions, there will of course be plenty to eat and drink.
We want to make new contacts and cultivate old friendships together with you in a relaxed atmosphere.

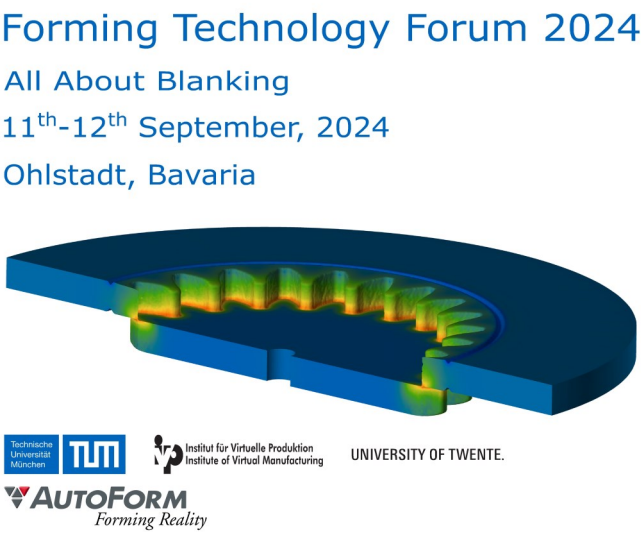
Where? Chair of Metal Forming and Casting,
Walther-Meißner-Str. 4, 85748 Garching

When? July 18, 2024 - Begin 4.00 pm

The official start is at 4 pm. This early start is particularly convenient for students. In the experience of recent years, most industry guests arrive from 6.00 pm.

To register by **July 5**, please use the registration link.


Foto: utg



September 11-12, 2024

All About Blanking

We are proud to announce the 15th FTF – Forming Technology Forum. This edition of the FTF runs under the motto „All About Blanking“.
The main goal is to gather scientific as well as industrial perspectives on this widely used process to get the best out of it.

We invite you to two days packed with a highly interesting program of exciting presentations, a poster speed dating session and many lively discussions.
And all this in a fantastic Upper Bavarian landscape.

Find out more:
15th-forming-technology-forum

Looking forward seeing you in Ohlstadt!

photo: Tourism Office Ohlstadt

Events at *utg*

September 17, 2024

1. User Meeting Freeform Bending

The BiegeZentrum Bayern Süd (BiZeBS) was launched in the fall of 2018 and has built up a great deal of expertise over the past six years.

Anwendertreffen Freiformbiegen
Connecting Industry and Research

Our focus is on the further development of the technology, both from a scientific and an industrial perspective. The aim is to exploit the full potential of the process and increase its use in the automotive sector.
With the user meeting, we now want to bring together trends and topics from research and industry.

Where? Chair of Metal Forming and Casting,
Walther-Meißner-Str. 4, 85748 Garching

When? September 17, 2024, 08.30 am to 03.30 pm

In the morning: Short talks from Research and Industry
After lunch: Discussions and workshops on key topics

Your participation is free of charge.
For better planning, please register by August 15 using this registration link.

Scan the QR code or click on the photo to see the video.

October 3, 2024

Open Campus Day

Have you always wanted to see what the Garching research campus has to offer? Then come to the open campus day.
A large number of institutions and companies invite you to take part in hands-on activities, presentations and information formats. The utg and the Fraunhofer IGCV will also be there! We look forward to welcoming curious visitors.

Where? Garching Research Campus

When? Oktober 3, 2024, 10.00 am to 5.00 pm

Find more information here:
https://forschungscampus-garching.de/

November 28, 2024

17th Bavarian Barbara Day

Where? Fraunhofer IGCV, Lichtenbergstr. 15,
85748 Garching

When? November 28, 2024

We will send out the invitations after the summer break in September 2024.

It's best to reserve the date in your calendar now!

Personnel at *utg*

We extend a warm welcome to:

Paul Richter, M.Sc.
joined the forming group at utg
on February 1, 2024.

Philipp Stöcks, M.Sc.
joined the blanking group at utg
on April 1, 2024.

We wish all the best for the future:

Dr.-Ing. Daniel Maier left the *utg*
on April 14, 2024.

Matthias Werner, M.Sc. left the utg
on May 15, 2024.

Dr. Liudmyla Lisova left the utg on
June 14, 2024.

New Dissertations at *utg*

43 **Senff, Mario Claudio**: Hybride Strukturbauteile für die Karosserie - Fügen von Aluminium und Stahl durch Verbundgießen und Rührreibschweißen, January 2024

44 **Dobmeier, Fabian**: Künstliche Intelligenz im Gießereiwesen - Stufenmodell und Einführungsmethode für Anwendungen in der Qualitätssicherung, January 2024

45 **Maier, Daniel**: Eigenschaftsflexibles Freiformbiegen mit bewegter Matrize, February 2024

46 **Hartmann, Christoph**: Removing stair steps by the use of local variation of binder concentration to achieve near net shape 3D printing, April 2024

47 **Gruber, Maximilian**: Equal-Channel Angular Pressing für industriell anwendbare Aluminiumblechwerkstoffe, April 2024

48 **Norz, Roman**: The Loading Direction and its Effects on the Material Behaviour of Sheet Metals, May 2024

49 **Welm, Markus**: Slug pulling prediction based on experiments, finite element simulation, and surrogate modeling, June 2024

All publications and dissertations of the chair are listed on the website www.mec.ed.tum.de/utg

The dissertations appear printed in the *series Metal Forming and Casting*, ed. Prof. Dr.-Ing. W. Volk, Kollemosch Verlag & Kommunikation, ISSN: 2364-6942

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Imprint

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Prof. Dr.-Ing. Wolfram Volk (v.i.S.d.P.)

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