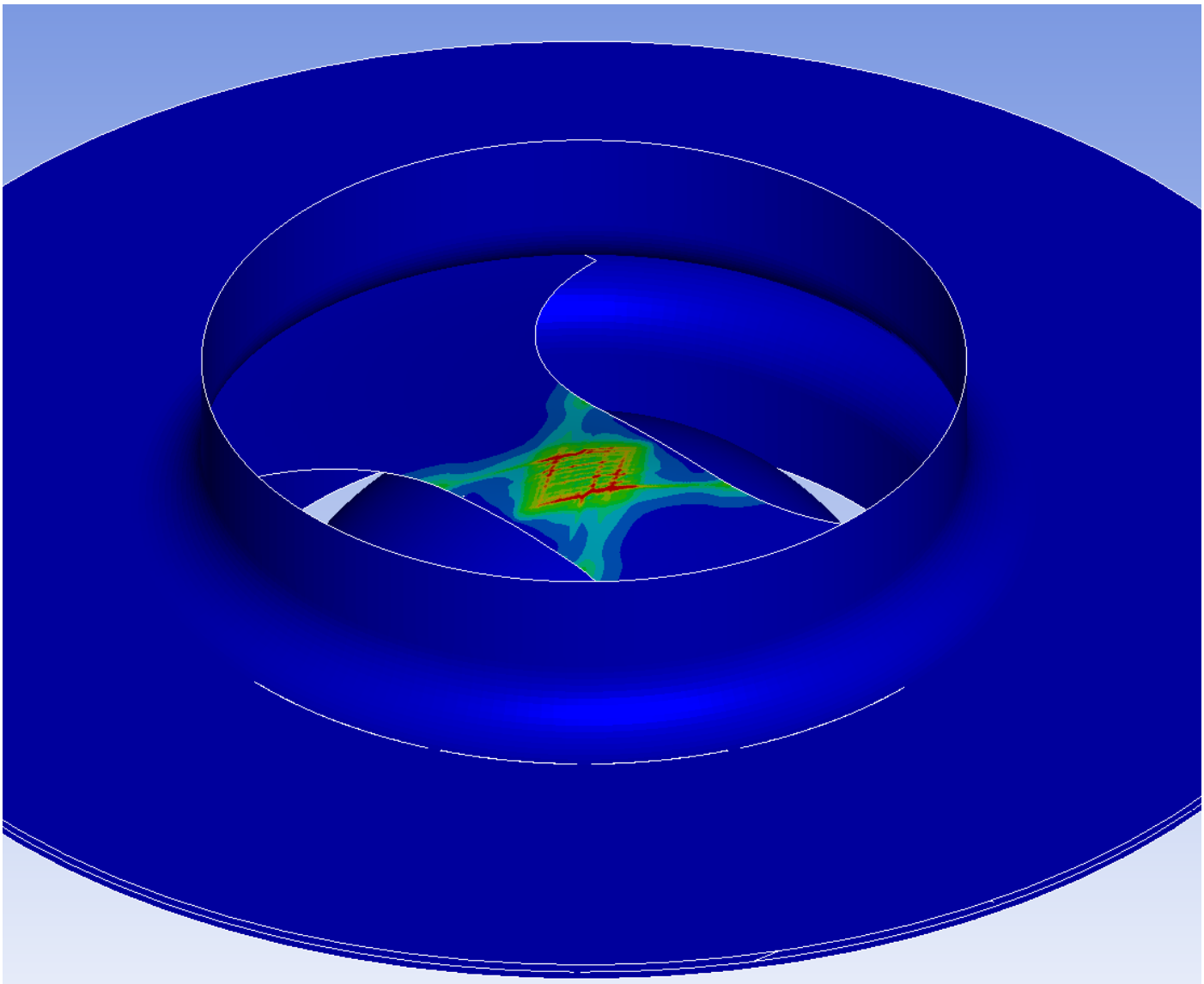
Chair of Metal Forming and Casting
TUM School of Engineering and Design
Technical University of Munich

utg Newsletter Issue 8 06/2023

Chair of Metal Forming and Casting



"I have learned that the path of progress is neither short nor easy."

Marie Skłodowska-Curie (1864 - 1934), Polish-French chemist and physicist

Editorial

Dear friends of *utg*,

it gives me great pleasure to present you with news and short insights into selected research projects of our chair.

In particular, I would like to emphasize the invitation to our in-house event on 20. July 2023. It would be a great pleasure for our entire *utg* team if as many of you as possible would accept our invitation and we could meet in the usual informal atmosphere in hopefully beautiful summer weather. For better planning, please register using the link in the newsletter.

Last year we had a comparatively large change of personnel at *utg*, and our very young employees especially are very happy to be able to continue the tradition of the in-house event with the elements of a summer festival.

Last week, the world's largest foundry trade show took place in Düsseldorf, and in addition to the sustainability debate, many exhibitors also focused on digitalization and inline process monitoring. In this context, our analysis furnace, affectionately called Gusstav, attracted a lot of attention and interest.

I would also like to recommend the article on the investigation of high-performance concrete for applications in forming technology. The third technical report in this newsletter deals with the reduction of wear in cutting and stamping technology, a well-known challenge that has been occupying us at *utg* for several decades now, with what we believe are always new and exciting results.

I hope you will find something of interest, and I look forward to seeing you at our in-house event on 20. July.

With best summer wishes and greetings

Yours

Wolfram Volk and the whole *utg* team

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

Frontpage Image:
Simulation of a Nakajima Test Shear Band, Sheet Metal Forming Testing Machine BUP 1000, Image: *utg*

utg News

Great Success at GIFA 2023

Every four years, the international foundry industry meets in Düsseldorf for the world's most important trade fair. Under the motto "The Bright World of Metals", experts from the fields of foundry and melting plants, plants and machinery for mold and core production, molding materials, modeling and molding, control technology and automation, environmental protection, and waste disposal, as well as information technologies meet.

The German Foundry Industry Association (BDG) traditionally occupies a large area in Hall 13 and also offers research institutes the opportunity to present themselves on the important "Road of Science" platform.

Together with colleagues from Fraunhofer IGCV, *utg* took the opportunity to present its current research priorities.

Important topics such as lightweight construction, process optimization and unique analysis possibilities were in the foreground. The great interest of the many visitors and the good contacts show that our research is addressing current issues in the industry.

The exhibition team was very committed and had a lot of fun. Whether in discussions or playing table football, *utg* was represented in a first-class manner.

Trade Exhibition Team of utg and Fraunhofer IGCV,
Foto: Fraunhofer IGCV

Prof. Volk is also a member of the Akademische Interessengemeinschaft Guss - akaGuss. The chairs and institutes organized there were also represented in Düsseldorf.

f.l.: Niels Skat Tiedje (DTU Lyngby), Babette Tonn (TU Clausthal), Lothar Kallien (HS Aalen), Wolfram Volk (TUM), Martin Fehlbier (Uni Kassel), Andreas Bührig-Polaczek (RWTH Aachen), Dierk Hartmann (HS Kempten),
Photo: Fraunhofer IGCV

Mentoring Program in Production Engineering

It is never too early for students to start making contacts and gaining insights into relevant fields of work. Since the summer semester of 2022, *utg* has therefore been working on the idea of a mentoring program that brings students and industry together.

A first project last year with a well-known foundry company, Pinter Guss, was extremely successful and very satisfying for both the company and the students.

utg News

Mentoring at and with the PINTER GUSS Company

a report by Martin Guggemos

"The mentoring program was initiated by Prof. Volk in the Foundry Technology and Rapid Prototyping lecture in the summer semester of 2022 with the aim of giving students interested in foundry technology insight into the industry and the professional environment.

I seized the opportunity and was assigned Dr. Greß from PINTER GUSS GmbH in Deggendorf as my mentor. The six-month program began with a tour of the company, during which I was able to see the entire process chain of a foundry. I was particularly fascinated by the large melting units, but the intense light source meant that I was only able to have a brief look inside the melt. I was also able to observe the casting process in gravity die casting, tilt casting, and sand casting. The post-processing of the castings, which in the case of sand casting includes the removal of the casting system and often the removal of the core, was carried out manually or by a robot.

As the program progressed, there were monthly online meetings where my mentor gave me tips on everything to do with studying and starting a career. The direct exchange also made it possible to discuss topics that are not part of everyday university life. I was able to benefit from the mentor's valuable experience and would therefore recommend the program to all students who want to go beyond the lectures and get to know the world of working as a production engineer."

We would like to extend the mentoring program to our other Master's courses and would be delighted to hear from interested mentors.

utg on Social Media

Since the beginning of May, the *utg* has its own LinkedIn channel. On this channel, we would like to share with all interested parties what is happening in, at, and around the Chair of Metal Forming and Casting (*utg*) at the TUM School of Engineering and Design (ED). The team around Wolfram Volk will use this channel to publish exciting insights into current projects, research topics, and events at the chair.

What content would you be most interested in? The team welcomes comments, suggestions, and likes. Feel free to share the page and posts at any time.

#community #TUM #utg #casting #forming #cutting #blanking

We have put a lot of effort and energy into video production over the last two years. The results are now online on YouTube! As well as great films about our research, there is also a collection of very interesting presentations from various conferences.

Again, we would love to hear your comments and likes.

You can also find all the videos on our website:

https://www.mec.ed.tum.de/utg/medien/

utg News

ESAFORM 2023 - We were there

The 26th ESAFORM took place in Krakow from 19. to 21. April. More than 300 participants presented their latest results and findings to an audience from 29 nations.

The diverse scientific program offered many exciting topics, from additive manufacturing to biomaterials. The Gala Dinner, which took place in the Polish Aviation Museum, crowned the successful conference.

utg was represented at ESAFORM by Daniel Maier and Roman Norz. The two presented their results on freeform bending and material characterization to an interested audience of experts.

In addition to the scientific program, Krakow with its beautiful old town also offered the opportunity to network with colleagues outside the conference. For example, the links with the partner university Aalto could be strengthened through personal conversations and further possible cooperation could be discussed. This showed the benefits of face-to-face meetings, which we had all missed during Covid-19.

All scientific conference papers were published in:

„Material Forming ESAFORM 2023“, Materials Research Pro-ceedings Volume 28, Publication Date 2023, 2164 Pages, ePDF ISBN 978-1-64490-247-9

Roman Norz (left) and Daniel Maier (right) represented utg in Krakow, Photo: utg

Award Winners at *utg*

The success story continues. Once again, two *utg* scientists have received awards:

This year's **EFB Project Award** went to **Markus Welm** for his research contribution on the topic of "Avoidance of High-Rising Slugs by Influencing Slug Friction".

The main reason for the slug sticking to the punch is the forces caused, for example, by lubricant adhesion. The release forces, caused by slug friction in the die channel, counteract the upward movement of the slug. If the sum of the adhesive forces exceeds the sum of all the release forces, the result will be punched slugs that rise.

In this project, Markus Welm investigated how to influence the slug friction to prevent the slugs from rising.

The results were published in
EFB Research Report No. 591.

Dr. **Philipp Tröber** won the **Hirschvogel Prize** of the Faculty of Mechanical Engineering for his thesis entitled "Adhesion Formation during Blanking and Deep Drawing under Consideration of Temperature and Thermoelectric Currents". In his work, Dr. Tröber was the first to demonstrate the significant influence of thermoelectric currents on adhesion formation during shear cutting and deep drawing. By influencing the thermoelectric currents, the amount of adhesion could be reduced by up to 70%.

The dissertation was published via mediaTUM.

Congratulations to both award winners!

Current Research at *utg*

Casting

New Analysis Furnace, e.g. for determining Gas Generation in Inorganic Molding Materials

Motivation

Inorganic binder systems are increasingly being used in the foundry industry due to the release of toxic substances during the processing of conventional organic compounds. The use of inorganic binders produces mainly water vapor, which is harmless to health but poses new challenges in the casting process. The released water vapor condenses in cooler areas of the core and eventually evaporates abruptly, which can lead to gas porosity. Our aim is to gain a better understanding of the gas generation and transport in inorganic sand binder systems and to simulate the material behavior.

Method

To this end, *utg* has developed a test rig for measuring the temperature-dependent core gas release and gas permeability of inorganically bonded foundry cores. The analysis furnace consists of a high-temperature furnace with 6 kW induction heating and pyrometers for temperature control.

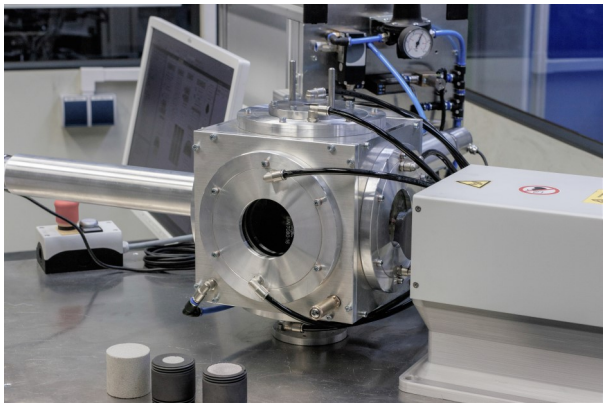


Fig.1: General View of Analysis Furnace, Photo: utg

The furnace chamber can be cooled with water and flooded with argon.
Graphite sleeves are used as test specimens into which the molding material is introduced in a core-shooting process. The graphite sleeves are heated inductively. The core gas is fed through a heated tube into a reservoir where it condenses. The change in mass of the reservoir can be used to determine the amount of core gas. The graphite sleeves are heated inductively. In the process, the core gas is fed via a heated pipe into a reservoir where it condenses. The change in mass of the reservoir can be used to determine the amount of core gas.
To measure gas permeability, a defined pressure profile is applied in the furnace chamber and the volume flow through the sample is recorded using a flow sensor. Initial measurement results are in good agreement with validation tests and the literature.

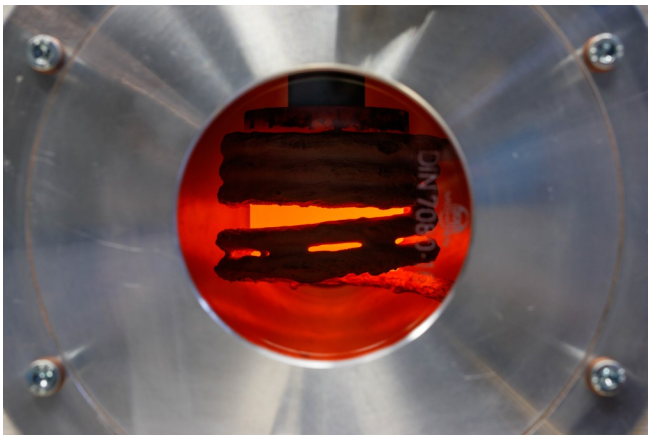


Fig.2: Heating Chamber with Induction Coil, Photo: utg

Outlook

The next step is to analyze samples of molding material with varying binder and moisture content. The measured data are then used to build a material model. This makes it possible to optimize the geometry of inorganically bonded foundry cores in order to avoid casting defects.

Versatile Analysis Furnace

In addition to the investigations described above, the flexible design of the analysis furnace also allows other tests to be carried out in which a sample is subjected to a specific temperature profile in a defined atmosphere. For example, it is already possible to produce ausferritic cast iron with nodular graphite on a laboratory scale. (see Newsletter 07). There are also plans to carry out hot tensile tests and simulate (composite) casting.

Contact: Simon Kammerloher, Benedikt Kirchebner

Current Research at *utg*

Forming

UHPC Sheet Metal Forming - Sheet Metal Forming with Active Elements made of Ultra-High Performance Concrete

Motivation

Compared to conventional concrete materials, ultra-high performance concrete (UHPC) is characterized by a small particle size of the cement and the addition of additives. This improves the packing density, which accelerates the hydration reaction and leads to higher strength properties. UHPC achieves compressive strengths of up to 200 N/mm2, with flexural strengths around 20 N/mm2.

In this research project, UHPC will be used as a tool material in forming technology. Due to the low material price and short manufacturing times, the use of UHPC tooling active elements is particularly feasible for rapid and near-series prototyping, for small series, or for one-off production.

Method

The composition of UHPC has been optimised for use in forming technology. In addition to reducing the water content, the addition of carbon fibre powder increases the flexural strength. A smooth and accurate surface immediately after casting is achieved by manufacturing using the Indirect Rapid Tooling approach. (see Fig.1)

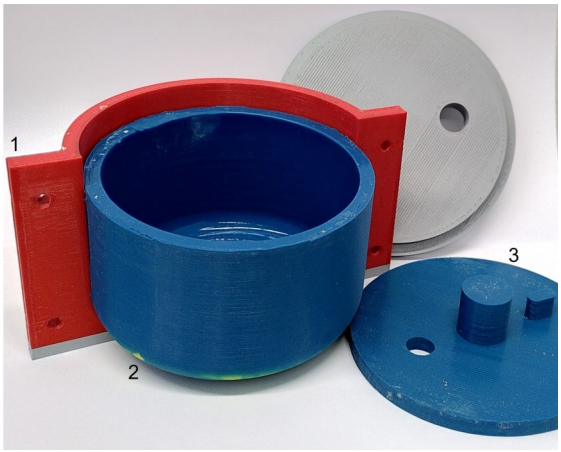


Fig. 1: Mold According to Indirect Rapid Tooling Approach, Photo: utg

The geometry is determined by the mold negative, which is built up additively.
Alternatively, an existing mold can also be cast. This is placed in a two-piece hard mold (1) and cast with silicone. The resulting silicone mold (2) ensures an accurate impression and a smooth surface. The casting side must always be reworked and determines the orientation of the geometry in the mold. A silicone cover (3) can be used to introduce structures, for example, to fix the active elements of the mold.

Results

For initial tests, the tool-active elements produced in this way (see Fig. 2) were integrated into the sheet metal testing machine available at *utg*.

Fig. 2: UHPC Tool Die and Punch, Photo: utg

Deep drawing tests with the cylindrical UHPC punch have produced good results to date. The punch has been repeatedly loaded with a maximum drawing force of over 95 kN without breakage or surface damage. The tests also show a high repeatability and a high surface quality of the drawn cups.

Outlook

Further work is aimed at optimizing the connection of the active mold elements, in particular the die, to the mold frame. The integration of internal or external prestressing mechanisms to increase the load capacity in the tensile area is also conceivable. These can be designed using the accompanying simulation studies.

Contact: Katja Holzer

Current Research at *utg*

Cutting and Punching Technology

Intelligent Mold Concepts Reduce Wear

Initial Situation and Motivation

Sheet materials such as aluminum, titanium, and stainless steel are being used in sectors such as the automotive and aerospace industries to realize the potential of lightweight construction. The problem with these materials is their high tendency to adhere. During industrial sheet metal processing (e.g. shear cutting, deep drawing), adhesion leads to sliver and in the following to tool damage, and reduced component quality. This results in shorter maintenance intervals and therefore higher costs.

Influence of Thermoelectric Currents

In previous research projects, *utg* has already demonstrated that thermoelectric currents influence adhesion formation. Thermoelectric currents are the result of a temperature gradient in the shear zone caused by the shear cutting process and the difference in the (material-specific) Seebeck coefficients of the tool and sheet materials. The greater the temperature gradient and the difference in Seebeck coefficients, the greater the thermoelectric current generated. The magnitude and direction of this current determines, among other things, the extent of cold welding.

The *utg* is pursuing two strategies to use the existing knowledge of thermoelectricity to reduce wear. On the one hand, the thermoelectric currents generated are to be reduced by adapting the Seebeck coefficients from tool to workpiece. The other is to counteract the in-process thermoelectric current with an external current.

Tool Coatings by means of Laser Metal Deposition

The *utg* and the Fraunhofer Institute for Laser Technology (ILT) are jointly pursuing the approach of adjusting the Seebeck coefficient by means of laser metal deposition. To achieve this, a tool material is coated with an established powder material using Extreme High-Speed Laser Application (EHLA) (see Figure 1).

This creates a combined system in which the Seebeck coefficients of the base and coating materials are combined.

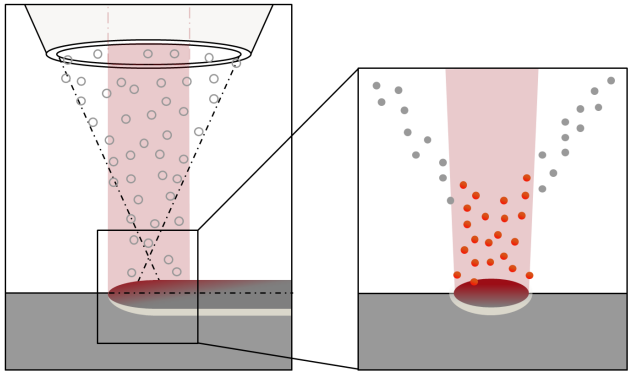


Fig. 1: Extreme High-Speed Laser Application (EHLA) for the Material-Bonding Coating of Tool Materials

External Currents

Together with project partner Hubert Stüken GmbH & Co. KG, *utg* is investigating countercurrents to reduce adhesion during shear cutting (see Figure 2). The first step in the series of tests is to determine the value of the optimum constant countercurrent over time. Then additional time-adjusted current characteristics (e.g. temperature, force, contact area) are considered.

Finally, the transferability of the results will be confirmed by continuous stroke tests on a production tool. In parallel with the project, a model will be developed to estimate the optimum external current on the basis of known characteristics.

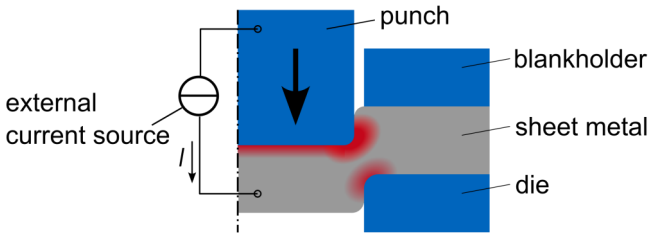


Fig. 2: Schematic Shear Cutting Process with External Current Influence

Contact: Kevin Prüfer, Bastian Stiegeler

Events at *utg*

20. July 2023
In-House Exhibition „Sommertreff at utg“

We cordially invite you to our traditional in-house exhibition! As well as many interesting discussions, there will of course be plenty of food and drink.

We want you to make new contacts and maintain old friendships in an informal atmosphere.

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

When? 20. July 2023 from 16:00

The official start time is 16:00. This early start is particularly convenient for students. Based on previous years' experience, most industry guests arrive from 18:00 onwards.

To register by **10. July**,
please use this registration link.

Save the Date - Bavarian Barbara Conference

Together with our foundry colleagues from the Fraunhofer IGCV, we will be hosting the Bavarian Barbara Conference again this year.

Where? Fraunhofer IGCV, Lichtenbergstr. 15, 85748 Garching

When? 30. November 2023

We will send out the invitations with registration options after the summer break in September 2023.

Best to put the date on your calendar now!

Personnel at *utg*

We extend a warm welcome to:

Kevin Prüfer, M.Sc.
joined the Cutting Group on
1. February 2023.

Bastian Stiegeler, M.Sc.
joined the Cutting Group on
1. February 2023.

Tianyou Liu, M.Sc.
joined the Forming Group on
1. February 2023.

Alexander Kindsmüller, M.Sc.
left utg on 28. February 2023.

Simon Vitzthum, M.Sc.
left utg on 28. February 2023.

Markus Welm, M.Sc.
left utg on 31. March 2023.

We wish all the best for the future:

Prof. Dr.-Ing. Philipp Tröber
left utg on 28. February 2023.

Dr.-Ing. Matthias Eder
left utg on 30. June 2023.

New Disstertations at *utg*

39. **Philipp Tröber**: Adhesion formation during blanking and deep drawing under consideration of temperature and thermoelectric currents, February 2023

40. **Matthias Eder**: Material Under Control: Validation of Material Models using the MUC-Test, March 2023

41. **Simon Vitzthum**: In-situ Analysis of Elastic-Plastic Characteristics of Steel Sheets, June 2023

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

Imprint

The *utg* Newsletter is published biannually and is edited by the

Chair of Metal Forming and Casting
Prof. Dr.-Ing. Wolfram Volk (v.i.S.d.P.)

TUM School of Engineering and Design
Technical University Munich

Walther-Meißner-Straße 4
85748 Garching near Munich

Editors:
Dipl.-Chem. Stefanie Prauser
stefanie.prauser@utg.de

Further information is available at:
www.mec.ed.tum.de/utg