The **Institute of Advanced Optical Technologies – Thermophysical Properties (AOT-TP)** offers a

Position as Research Assistant (m/f/d) with the perspective of a doctorate

for a research project with the title

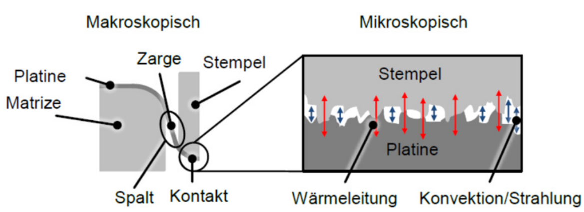
Modeling of Heat Transfer in the Hot Stamping Process

The position is part of a joint project of the Institutes for Advanced Optical Technologies – Thermophysical Properties (AOT-TP) and for Manufacturing Technology (LFT) at FAU and the Chair of Forming Processes (FF) at TU Dresden, funded by the German Research Foundation (DFG). Overall, the project deals with the experimental investigation and modeling of heat transfer during hot stamping against the following background.

The growing relevance of ecological aspects as well as governmental regulations regarding CO_2 emissions are only two factors for the increasing importance of lightweight design in the automotive industry during the last decade. Especially hot stamping of ultra-high-strength boron-manganese steels has developed to a state-of-the-art process for manufacturing safety-relevant car-body parts. The process of hot stamping starts with a full austenitization of the semi-finished parts above the alloy specific AC_3 temperature. After the heat treatment, the hot sheets are directly transferred to the press, where they are subsequently formed and in-die quenched. As long as the cooling rate exceeds a specific value, the austenite completely transforms into martensite. Due to this phase transformation, the hot stamped parts exhibit an ultimate tensile strength of at least 1500 MPa.

The temperature evolution along the process chain and in particular during in-die quenching has a significant influence on the final mechanical properties. For a precise numerical process design, exact modelling of the heat transfer in the contact area between workpiece and tool is important. In the finite-element method, a corresponding heat transfer coefficient is used for modelling, either in the form of a constant value for the whole process or as a function of the contact pressure. This leads to significant uncertainties in terms of the numerical process-modelling results. Although more complex models are available in the literature, these models are primarily valid for a constrained series of experiments.

Therefore, the present research project aims to acquire a fundamental understanding of the heat transfer mechanisms involved in the hot stamping process and to model them for the numerical process design. The analysis of the heat transfer during hot stamping is realized through a representative series of experiments under systematical variation of the process parameters. During the experiments, the temperature evolution of the workpiece and the tool is recorded and used for the calculation of time-dependent heat transfer coefficients. This experimental data as well as additional measurement results on the evolution of the surface topography are the basis for the development of a physically-based model, which has the ability to determine time-dependent heat transfer coefficients in the contact area between workpiece and tool as a function of



the process parameters. Since the heat transfer also depends on the respective contact situation, the different conditions of contact will be modelled for the numerical simulation as well. By combining the heat transfer model with a submodel for the continuous evaluation of the true contact area between workpiece and tool, the prediction quality of the numerical process design will be improved.

The position advertised here addresses the subtasks of the joint project assigned to AOT-TP. First of all, the thermal design of the experimental apparatus to be installed at LFT and the implementation of a corresponding data evaluation procedure for the determination of temporally resolved heat transfer coefficients from the experiments are to be carried out in cooperation with LFT. The main focus, however, is on the continuous development of a physically based modeling of the heat transfer between the tool and workpiece surfaces during press hardening, taking into account the heat transfer mechanisms contributing at the microscopic scale. These include heat conduction at the actual metallic contact points and heat conduction or convection as well as heat radiation within the microscopic cavities formed by surface roughness between workpiece and tool. The influences of already existing surface roughness and the changing surface roughness during the process are the main contact points to the project contents of FF.

For the research project, we are looking for a scientist with a completed Master's degree in a suitable field and strong interest in theoretical work in the field of thermal engineering. Previous knowledge of the MATLAB programming language as well as experience in the field of heat transfer is welcome. We offer a multidisciplinary, team-oriented, and international working environment with excellent potential for scientific and personal development.

The position is to be filled as of 01.01.2023. It is limited to 2 years with the possibility of extension. With appropriate qualifications and suitability, payment is based on pay group 13 according to TV-L.

If you are interested in working with us, please send your application documents to

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