BRAGECRIM Newsletter

1st Edition: June 2017

BRAGECRIM - Smart Connected Manufacturing

Dear reader,

we welcome you to the 1st edition of the BRAGECRIM newsletter. In the following pages you will find updates about recent activities within the different BRAGECRIM projects with content ranging from current research results, kick-off and final meetings over contributions to conferences to publications.

We hope that you will enjoy reading this newsletter edition!

Best regards,

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8th annual BRAGECRIM meeting held in Bremen for the first time

The 8th annual BRAGECRIM meeting was held from November 14-16, 2016 at BIBA – Bremer Institut für Produktion und Logistik at the University of Bremen. The meeting brought together the Brazilian and German researchers of the joint BRAGECRIM projects as well as members of the funding bodies DFG and CAPES and interested industry participants. Starting with a get-together on November 14, the following two days featured interesting presentations of all current BRAGECRIM projects as well as the visions of the funding agencies. Particular highlights were two keynote presentations of two employees of Robert Bosch GmbH as well as Volkswagen AG regarding "Connected supply chains as a key for future production networks" and "Recent advances in big data analytics and their impact on automotive challenges". Fruitful discussions of the BRAGECRIM meeting participants took place especially at the gala dinner at the Bremer Ratskeller in the historical city center.

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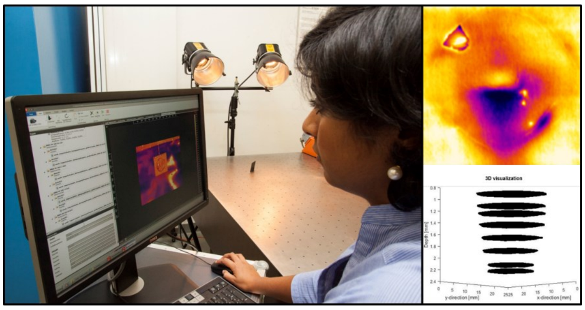
IDD-Metro

Active lock-in thermography enables 3D measurements of defects in CFRP

Research topic of the project IDD-Metro is the non-destructive testing of carbon fibre reinforced plastics (CFRP) with shearography and lock-in thermography. The researchers of the RWTH Aachen University, who focus on the examination with optical lock-in thermography, developed an evaluation algorithm to generate 3D information out of lock-in thermography data. The recent outcomes enable the examination of CFRP structures in the repair shop environment.



For the investigations at the RWTH Aachen University the researchers manufactured multidirectional CRFP samples with blind bore holes. In a first step, the optimal experimental setting parameters for the examination with thermography were determined. The blind bore hole samples with defined bore hole diameters and remaining wall thicknesses enable the analysis of the depth resolution of the thermography system. To gain knowledge about the depth resolution and the lateral heat flows the CFRP test samples were investigated with different excitation frequencies. The results illustrates that with decreasing excitation the penetration depth into the part increases. To generate 3D information of the part's defect, a stack of images with different excitation frequencies is evaluated. Simultaneously for calibration, the blind bore bole samples are measured on the coordinate measuring machine (CMM). The deviation between calibration and thermography measurements is analysed and considered determining the actual defect's geometry. A software with a user-friendly interface is developed to measure defects in CFRP parts in the repair shop environment.

In upcoming investigations, the correlation of part structure and setting parameters is extended. Further, the procedure is adopted for internal defects as impact damages. The target is the illustration of internal defects in a 3D model. In addition, the researchers from the Universidade Federal de Santa Catarina (UFSC) work on the combination of thermography and shearography and data evaluation based on the principle of sensor data fusion.

First outcomes are demonstrated on the AWK "Aachen Machine Tool Colloquium 2017" that will be held from May 18-19th and presented on the "1st CIRP Conference on Composite Materials Parts Manufacturing", in Karlsruhe on June 8-9th 2017.

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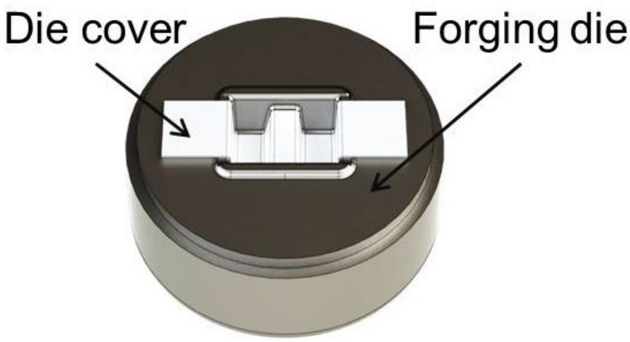
ForCover

Evaluation of sheet metal covers to improve tool life in forging



The idea of ForCover (acronym for forging covers) is inspired by exchangeable cutting tool inserts. Many years ago, cutting tool inserts strongly improved the process and material efficiency in metal cutting industry because they can be produced in large quantities and can be exchanged easily. Now, the exchangeable ForCover is proposed as a promising solution to decrease the tooling costs in closed-die forging. This concept aims to develop an inexpensive and easily exchangeable sheet metal die cover to protect the engraving during the forging stroke. By using this sheet metal die cover, the thermal shock, mechanical loads and mechanical wear can be reduced. Instead of the die surface, the die cover is subjected to the peak loads during the process and will be worn-out. After a certain degree of damage, the die cover will be replaced by a new one.

The project ForCover was first proposed in 2014. Since then, general studies on suitable material combinations, geometries, boundary conditions etc. have been performed. Accordingly, several experiments were conducted to prove the feasibility of this concept. Results indicate that the ForCover is effective to reduce the die wear and increase the tool life. E.g., a numerical case study shows that by using a die cover the maximum temperature of the forging die can be reduced by 140 °C, and the temperature amplitude can be reduced by 37% from 240 °C to 150 °C. Additionally, the mechanical load decreases from 1239MPa to 1075MPa. Thus, based on a die lifetime calculation developed by IBF, an increase of 210% on the tool life of forging die can be expected. In experimental validation, challenges caused by wrinkling and thinning arise in the first experiment. By analyzing various materials, geometries and boundary conditions, the problems were identified. After optimizations, the die cover can endure 10 forging cycles without deformation. In future, the improvement of boundary conditions, the range of suitable geometries and the application of ForCover in multi-stage forging process will be investigated.

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Micro-O

Micro Milling Process Optimization

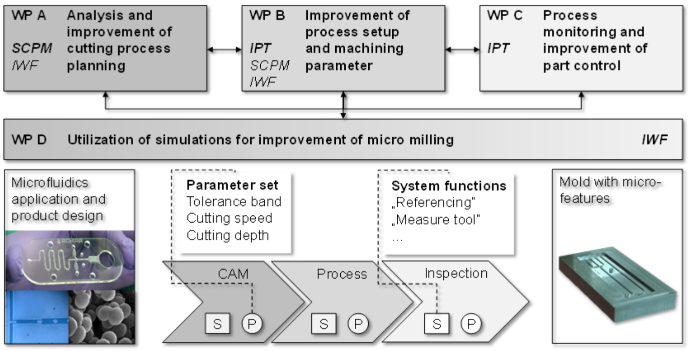

Figure 1 Project approach first research period

Modern technological devices demand high precision components and due to increasing miniaturization of these components, the industries are faced to new challenges in the manufacturing processes. Micro-machining has several advantages among these new manufacturing processes, due to its capability of producing complex, high-precision geometries with micro-features in a wide range of materials. However, it has different phenomena compared to conventional machining. In order to increase their application in industries, micro-machining processes must fit in productivity and quality standards, thus needing further research to comply with these requirements.

In this context, the project Micro Milling Process Optimization (Micro-O) has been initiated in the scope of BRAGECRIM (Brazilian-German Collaborative Research Initiative on Smart Connected Manufacturing), which is a Brazilian-German research platform for exchanging and developing know-how among partners, supporting research institutes and industries in both countries in achieving higher competitiveness levels on micro machining technologies. Micro-O's main goals are to improve micro-production chain, developing knowledge regarding machining process and the setup procedure as well as part control and process simulation.

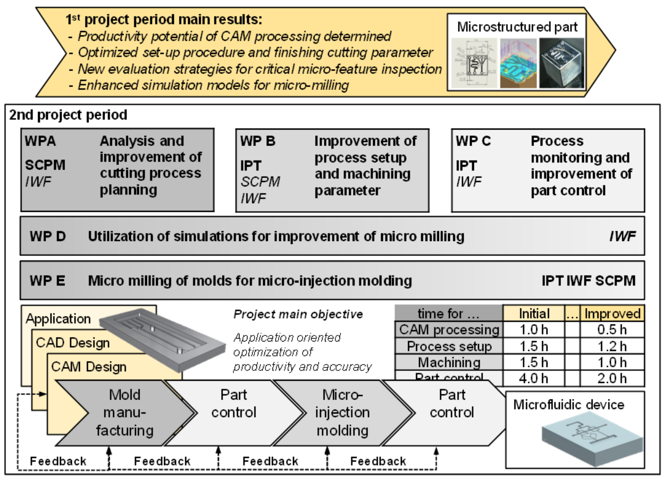

Figure 7 Project approach for second research period

Initial results based on experiments conducted on a micro-machining center have been presented in a conference article, in which the procedures "design", "tool path generation", "process setup", "machining" and "part inspection" have been documented and analyzed with regard to their time consumption. Further journal and conference publications allowed showing the progress of the project. Up to now six study and seven work missions helped to intensify the cooperation. Especially the involvement of Brazilian and German students with up to now five completed Bachelor and Master Theses was gainful for successful project progression. Significant results generated by the project team in 2016 regarding virtual micro milling, optimum cutting parameter studies, innovative monitoring systems for workpiece condition testing and new strategies for quality determination of micro-milled are under publication progress in international journals and conferences.

Building on the results of the first project period, the second project period is designated to completing the manufacturing chain by including the micro-injection molding process in the optimization measures and deriving new approaches for conveniently defining and assessing accuracy and quality requirements of the micro-mold.

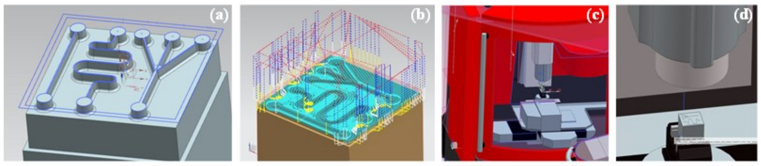

Figure 2 CAD/CAM processing: (a) CAD part with micro features; (b) CAM tool path generation; (c) kinematic model of KERN Evo; (d) Virtual machine simulation

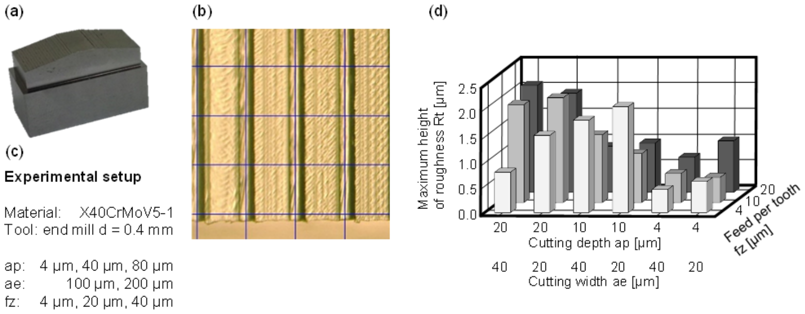

Figure 3 Experiments for determination of process parameter impact on surface roughness (a) Picture steel part (b) Measured surface with detail (c) Experimental setup (d) Line roughness Rt measured on each step

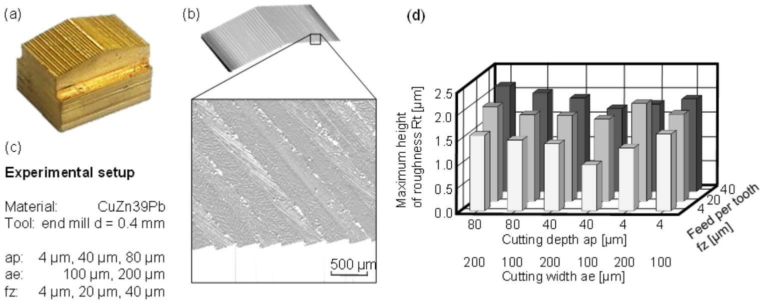

Figure 4 Experiments for determination of process parameter impact on surface roughness (a) Picture brass part (b) Measured surface with detail (c) Experimental setup (d) Line roughness Rt measured on each step

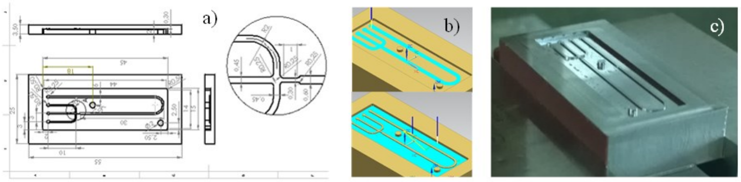

Figure 5 Manufacturing process chain: (a) design of mold with micro features; (b) CAM tool path generation of finishing operations; (c) Machined workpiece

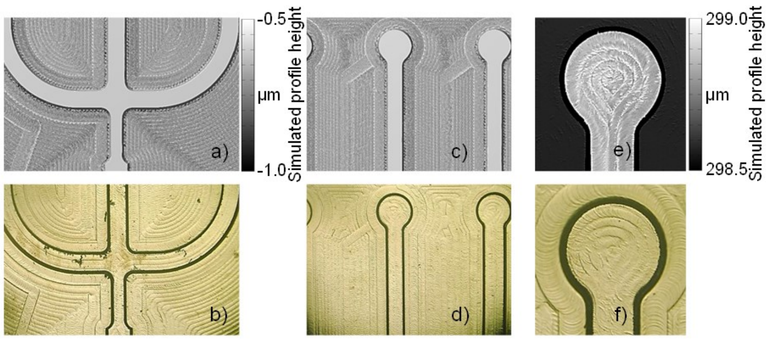

Figure 6 Comparison of measured and simulated mould topography for simulated a), c) and optically observed b), d) floor surface as well as simulated e) and optically f) observed channel top surface

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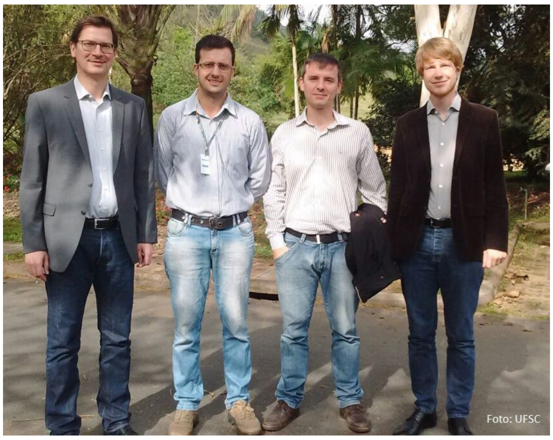
AdaptiveSBO

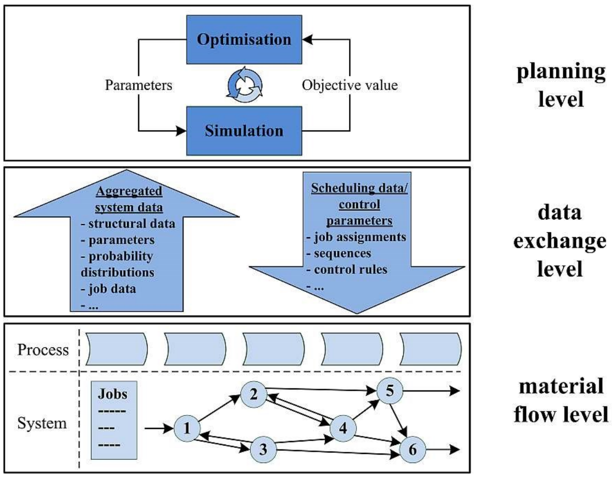
Kickoff-Meeting of the Project AdaptiveSBO

The aim of the research project "AdaptiveSBO" is to develop an adaptive simulation-based optimization method for the scheduling and control of dynamic manufacturing systems. In Germany, the director of the BIBA, Prof. Dr.-Ing. Michael Freitag, coordinates the project, while Prof. Dr.-Ing. Enzo Morosini Frazzon from the research group Production and Logistics Intelligent Systems at the Federal University of Santa Cararina (UFSC) coordinates it in Brazil. Rudolph Usinados, a Brazilian manufacturing company for mechanical components for the automotive industry, which was founded by German emigrants, also takes part in the research project AdaptiveSBO. Therefore, the kickoff meeting of the project was held at Rudolph in September 2016.



AdaptiveSBO

Presentation of current research results at the Winter Simulation Conference 2016 in Arlington, Virginia, USA



The increasing customization of products, which leads to greater variances and smaller lot sizes, requires highly flexible manufacturing systems. These systems are subject to dynamic influences and demand increasing effort for the generation of feasible production schedules and process control. The paper "Potential of a data -driven simulation-based optimization approach for an adaptive scheduling and control of dynamic manufacturing systems" presents an approach for dealing with these challenges. First, production scheduling is executed by coupling an optimization heuristic with a simulation model. Second, real-time system state data, to be provided by forthcoming cyber-physical systems, is fed back, so that the simulation model is continuously updated and the optimization heuristic can either adjust an existing schedule or generate a new one. The potential of the approach was tested by means of a use case embracing a semiconductor manufacturing facility, in which the simulation results were employed to support the selection of better dispatching rules, improving flexible manufacturing systems performance regarding the average production cycle time. The paper was presented at the premier conference regarding simulation, the Winter Simulation Conference from December 11-14, 2016 in Arlington, Virginia.

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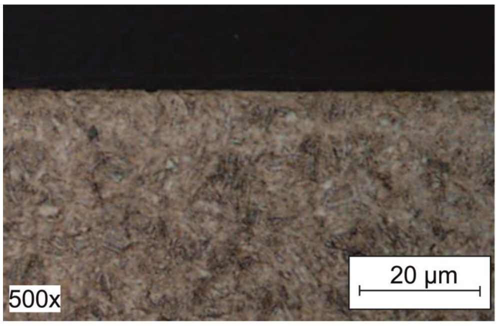
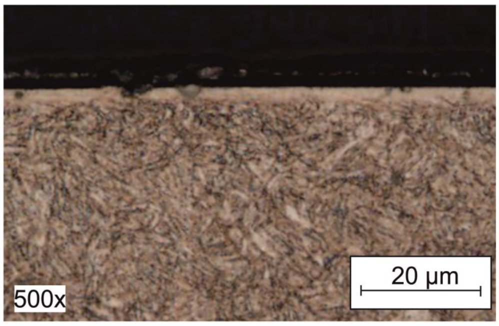
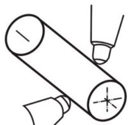
Relax

Influence of the manufacturing process on the subsequent residual stress relaxation in AISI 4140 steel





Hardness [HRC]	40	50
Rolling velocity vf [m/min]	90	90
Feed rate f [mm]	0.05	0.05
Hydrostatic pressure p [Mpa]	20	5
Number of passes n [-]	1	1



In the beginning of December 2016, German research fellow Kolja Meyer (IFW) visited the partners from the UFMG in Belo Horizonte in order to perform the rotating bending tests from WP6. The aim of these investigations was to link the overlap of manufacturing induced residual stresses and load stresses to possible relaxation of residual stresses. The residual stress measurements are still in performance. During this stay, it was also possible to attend the PhD defense of Dr. Jean Carlo Pereira, who was involved in an exchange to Germany in 2015.

From November 2016 until the end of March 2017, Brazilian master student Diogo Azevedo investigates the formation of deep rolling induced white etching layers on AISI 4140 steel. These layers occur due to thermal and mechanical influence from manufacturing processes, such as turning and grinding. There is no preliminary knowledge about the influence of deep rolling on the formation of said layers. For certain parameter sets, it was possible to generate white etching layers on AISI 4140 samples as visualized.

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