PROZESS SIGNATUREN

TRANSREGIONALER SONDERFORSCHUNGSBEREICH 136

Processes with predominant mechanical impact

Subproject F01/Strengthening – Prof. Dr.-Ing. habil. Carsten Heinzel, Dr.-Ing. Daniel Meyer

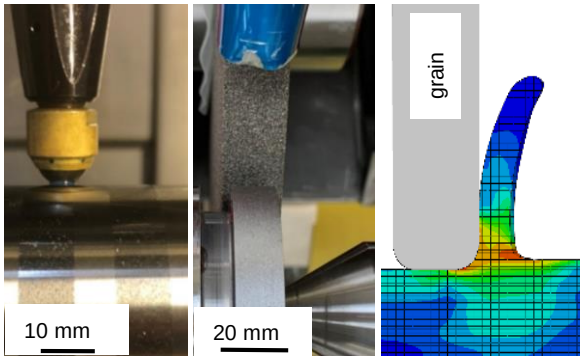
Objective and approach

Subproject F01 investigates internal material loads and modifications in the surface and subsurface of workpieces for manufacturing processes with predominant mechanical impact. For this purpose, two manufacturing processes with different intensities are considered (deep rolling and grind-strengthening). Experimental investigations and analytical models as well as numerical simulations are used to determine the internal material loads and modifications. The purpose is to identify correlations that contribute to the development of process signature components for processes with predominant mechanical impact.

State of the art

Process signature components were developed for both manufacturing processes depending on the system and process parameters varied in a stress-oriented manner. The material modification (residual stress change) can be described as a function of the originating loads. In case of deep rolling, investigations of the parameters for the modification were carried out for repeated internal material loads during surface machining. It was possible to correlate the maximum of the analytically determined internal material load with the maximum of the resulting residual stresses. These internal material loads were simulated in cooperation with subproject M01.

In case of grind-strengthening, simulated internal material loads were used to generate a correlation with experimentally generated modifications by means of adapted grinding wheels with defined grains. In addition, investigations were carried out on the influence of process chains and machining steps or sequential processes.



left: deep rolling, middle: grind-strengthening, right: simulation of single grain engagement

Conclusion and outlook

For the investigated processes, the process signature components were extended by the aspect of multiple internal material loads. For this purpose process chains with varying process parameters were investigated for deep rolling and grind-strengthening. In cooperation with other subprojects, the mechanisms of the material modifications for the predominant mechanical impact were revealed. The individual processes as well as a combination (deep rolling and grinding-hardening) shall be used to optimize the surface properties for the function of the components in order to increase the component service life. For the first time, complete specific depth profiles are targeted to be induced into the workpiece. Thus, the mechanism-based correlation between the internal material loads and the modifications for processes with predominant mechanical impact will be transferred to a specific, function-oriented and process-independent design of the entire manufacturing chain.

Publications

[1] Borchers, F.; Meyer, H.; Heinzel, C.; Meyer, D.; Epp, J., Procedia CIRP, 2020.
[2] Borchers, F.; Clausen, B.; Eckert, S.; Ehle, L.; Epp, J.; Harst, S.; Hettig, M. Klink, A.; Kohls, E., Meyer, H.; Meurer, M.; Rommes, B.; Schneider, S.; Strunk, R.; Metals, 2020.
[3] Ehle, L.; Strunk, R.; Borchers, F.; Schwedt, A.; Clausen, B.; Mayer, J., Procedia CIRP, 2020.
[4] Eich, M.; Borchers, F.; Karahan, A.; Langenhorst, L.; Heinzel, C.; Procedia CIRP, 2021.
[5] Hettig, M.; Meyer, D.; Procedia CIRP, 2020.
[6] Kämmler, J.; Wielki, N.; Meyer, D. , Procedia CIRP, 2018.
[7] Kämmler, J.; Borchers, F.; Meyer, D.; Heinzel, C., euspen's 18th International Conference, 2018.
[8] Langenhorst, L.; Borchers, F.; Heinzel, C., Procedia CIRP, 2018.