PROZESS SIGNATUREN
TRANSREGIONALER SONDERFORSCHUNGSBEREICH 136

Electrochemical Machining as Process with Main Chemical Active Principle

Subproject F03/ECM – Dr.-Ing. Andreas Klink

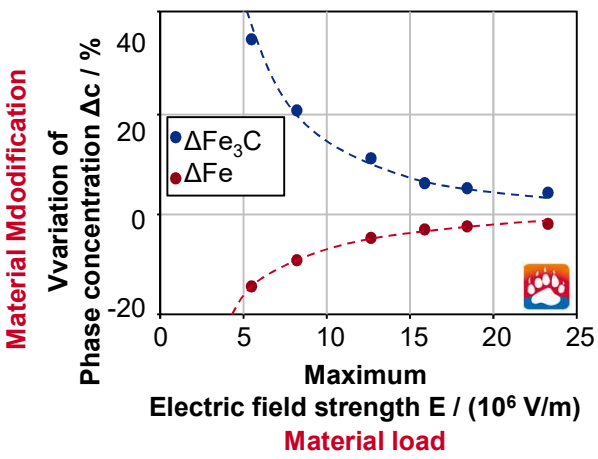
Objective and approach

In subproject F03, a process signature for processes with chemical main active principle is to be developed and made usable. For this purpose, the process of electrochemical machining (ECM) is investigated as a representative example of manufacturing processes with chemical main principles. For this purpose, the stresses occurring in the process, as well as the resulting modifications, are investigated both experimentally and simulation-based. The experimental and model-based environments are developed on the one hand in the subproject itself and on the other hand through various collaborations within the SFB-TRR136.

Current state of knowledge

The approaches to the process signature component "phase change" developed in the first funding period were finalized and validated in the second period. Based on the experimental investigations in cooperation with the subproject C02/electron microscopy, a numerical model was set up to describe the anodic dissolution behaviour of the different material phases for the ferrite-pearlite (FP) state of the material 42CrMo4. In addition, two other relevant process signature components were formulated, which contribute significantly to the description of the overall electrochemical process signature. Thus, the intensity of the phenomenon of pitting corrosion was defined as a modification variable and combined with the maximum electric field strength occurring as a stress to form a signature component. Furthermore, the phenomenon of flow ripples was investigated. A probabilistic process signature component was formulated, with the probability of formation of the flow-induced crater structures as the modification variable and the wall shear stress as the stress variable.

Siganture Component Phase change



Conclusion and further procedure

In the project period to date, the main focus of the chain of effects has been on the relationships between the process-specific chemically dominated material loads and the resulting material modifications based on corresponding process signature components. Currently, the topic of recurring loads is being investigated in particular, both in process chains and within the individual process for the pulsed ECM machining variant (PECM). In order to enable function-oriented manufacturing, it will be necessary in the future to solve the "inverse problem of manufacturing technology" along the entire chain of action from machine settings to component function. In a first step, the effects of material modifications on selected functional properties must be analyzed in detail for the ECM process. In particular, high-temperature oxidation resistance, flexural fatigue strength and tribological properties are treated as process-relevant functionalities. Subsequently, these properties are to be coupled in an overall model together with the developed process signature and further manufacturing processes in order to ensure a consistent description of the functional chain.

Publications

[1] Bergs, T.; Harst, S.: *Development of a Process Signature for Electrochemical Machining*. CIRP Annals Manufacturing Technology 69 (2020), pp. 153-156 DOI: 10.1016/j.cirp.2020.04.078

[2] Bergs, T.; Rommes, B.; Kohls, E.; Meyer, H.; Klink, A.; Heidemanns, L.; Harst, S.: Experimental Investigation concerning the Influence of Electrochemical Machining on Process Chain induced Residual Stress States. Procedia CIRP (2021), 95, pp. 726-730 DOI: 10.1016/j.procir.2020.01.170

[3] Harst, S.: Entwicklung einer Prozesssignatur für die elektrochemische Metallbearbeitung. Dissertation RWTH Aachen University Apprimus Verlag 2020

[4] Rommes, B.; Klink, A.; Herrig, T.; Vorspohl, J.; Ehle, L.; Bergs, T.: Formation of Flow-Grooves during Electrochemical Machining. Proceedings of the 16th International Symposium on Electrochemical Machining Technology INSECT, 24-25 November 2020, Chemnitz, Germany, pp. 27-32 ISBN: 978-3-95735-125-8