Electrical Discharge Machining as Process with Main Thermal Active Principle
Subproject F02 – Dr.-Ing. Andreas Klink

Objectives and Approach
The objective of subproject F02/EDM is a comprehensive investigation of a thermo-physical based correlation of the resulting surface and rim zone properties and the temporal heat dissipation in electrical discharge machining (EDM). By the reduction of all process parameters to general physical quantities the process can be described unambiguously and fundamentally. This is the base for implementing Process Signatures.

Project Activities and Findings (June 2019)
First a simulation model was built to determine the thermal loadings of a single discharge during EDM. Due to high temporal and spatial gradients a measurement of them was not feasible. With the developed simulation model it was possible to determine the material loadings numerically [1]. However, these simulations are very sensitive to the amount of the energy distributed to the workpiece material, which is generally unknown. Thus, various approaches were applied to determine this energy [2]. Currently, another approach is investigated based on the gas bubble dynamics in the gap. This as well as the transfer of the single discharge model to a multiple discharge model are recent activities in close cooperation with project M04/Transport mechanisms.

On the modification side, e.g. residual stresses and microstructure modifications were determined in cooperation with subprojects C01/Diffraactometry, C02/Electron microscopy.

In the second phase it will be focused on modelling microstructure modifications. The phase field method is developed for the description of the dynamics of the multiphase systems. Using this method the microstructure evolution of the reference steel grade (42CrMo4) under high thermal cycles with high temporal gradients is calculated as it is the case for EDM process [3]. During the heating process the austenitization transformation is activated and during the cooling process the formed austenite grains transform to martensite. The results of this simulations are given below.

Overview of research in subproject F02

Conclusions and Further Tasks
Fundamental challenge in EDM is to gain knowledge about the heat dissipation into the workpiece to calculate the material loadings accurately. If this is known the phase transformation and hence the material modification can be predicted. Next step is to combine different types of loadings sequentially to determine the superimposition effects and to verify the concept of process signature.