Single Discharge Simulations of Needle Pulses for Electrothermal Ablation

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Abstract

In micromachining are steadily higher precision and better surface qualities required, while productivity should not be importantly reduced. At the usually utilized high energetic discharges edge layers ("white layers") with a high hardness arise. These layers influence the operational behavior of erosion components. So they need an expensive finishing. Using stages pre- and post-processing needs a higher ablated volume. Thus an innovative development of this process under the points of resource efficiency belongs a high importance. To improve the resource efficiency of processing by spark erosion is sought that a thermal unaffected surface with highest machining accuracy and suitable surface roughness already emerges with the processing step of the spark erosional ablation. The specific approach is to control the process or to reduce the pulse energy by the pulse duration as far as that the pulse energy can be introduced over a large area.

Within this study a model of a single discharge of micro scale EDM was developed in accordance with Schulze et al [1]. Figure 1 shows a general model of the plasma channel during EDM. The specific computation of the growth of the plasma channel has been derived from this literature.

Applying COMSOL Multiphysics® a pseudo 3-D geometry was created based on the literature data. Afterwards the thermal heat transfer in solids was defined as well as the parameters and current and voltage curve [2]. Within the plasma channel a high degree of temperature results. These temperatures are partially directed into the workpiece surface. To visualize the crater of molten material, all mesh elements with a temperature higher than the melting point of the work piece material were defined as ablation geometry.

Figure 2 shows the resulting crater under the given conditions. It can be seen that a relatively shallow depression is created.

Reference

[1] Schulze, H; Leone, M; Kröning, O; Schätzing, W; Simulation of thermal effects for Electrical Discharge Machining, Nonconventional Technologies Review – No. 1 / 2007
[2] Zeidler, H.; Schwingungsunterstützte Mikro-Funkenerosion, Dissertation, TU Chemnitz, 2011

Figures used in the abstract

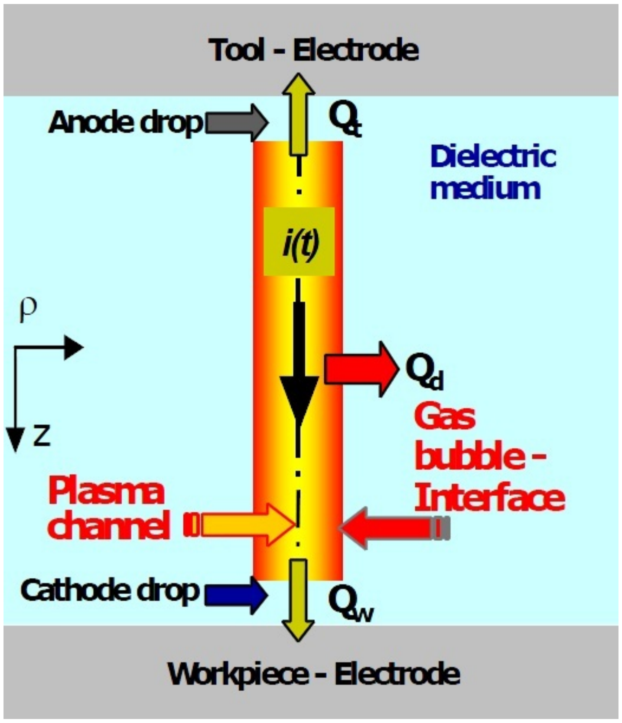

Figure 1: Model of discharge channel [1]

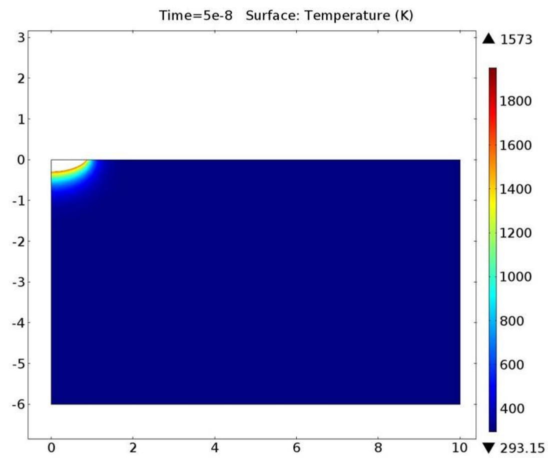

Figure 2: Resulting crater