Pulsed Electric Field Based Material Removal in Micro Electrical Discharge Machining

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Introduction: Material removal phenomena in micro electrical discharge machining (MEDM) has extensively been modelled by assuming plasma channel to be a heat source of certain configuration viz. Gaussian [1], point, uniform and so on. In this study, our approach was to model the material removal based on electric field fluctuations due to charging and discharging of capacitor in an RC circuit (Fig. 1).

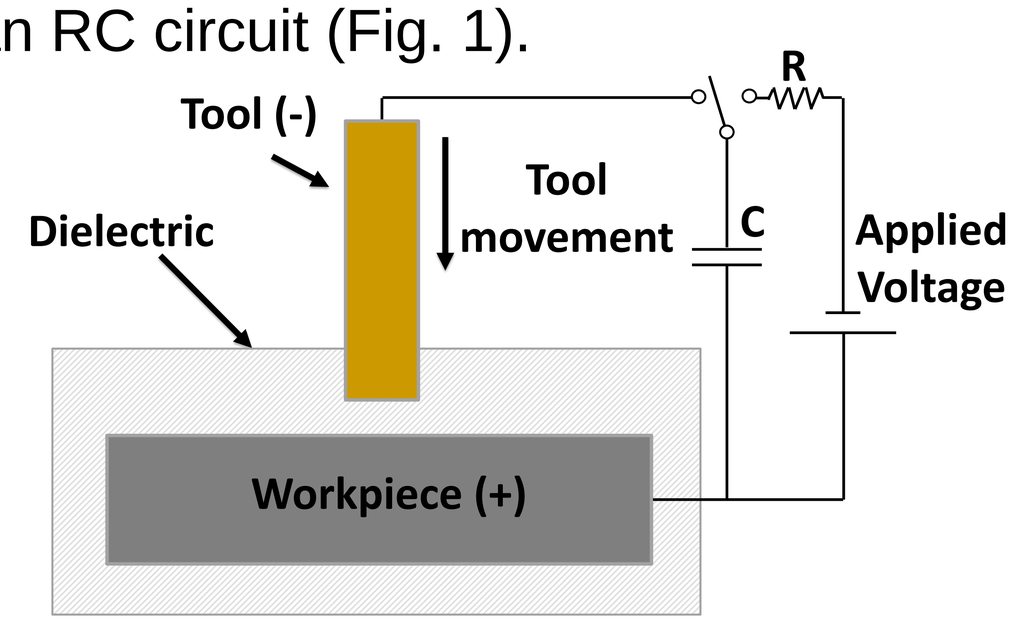

Figure 1. RC circuit in MEDM

Computational Methods: In our model, a sinusoidal pulse has been assumed to simplify the complex nature of charging and discharging of capacitor. At locations on the workpiece (Fig. 2) where electric field crossed the threshold value, a constant heat flux was applied which removed material from that particular location.

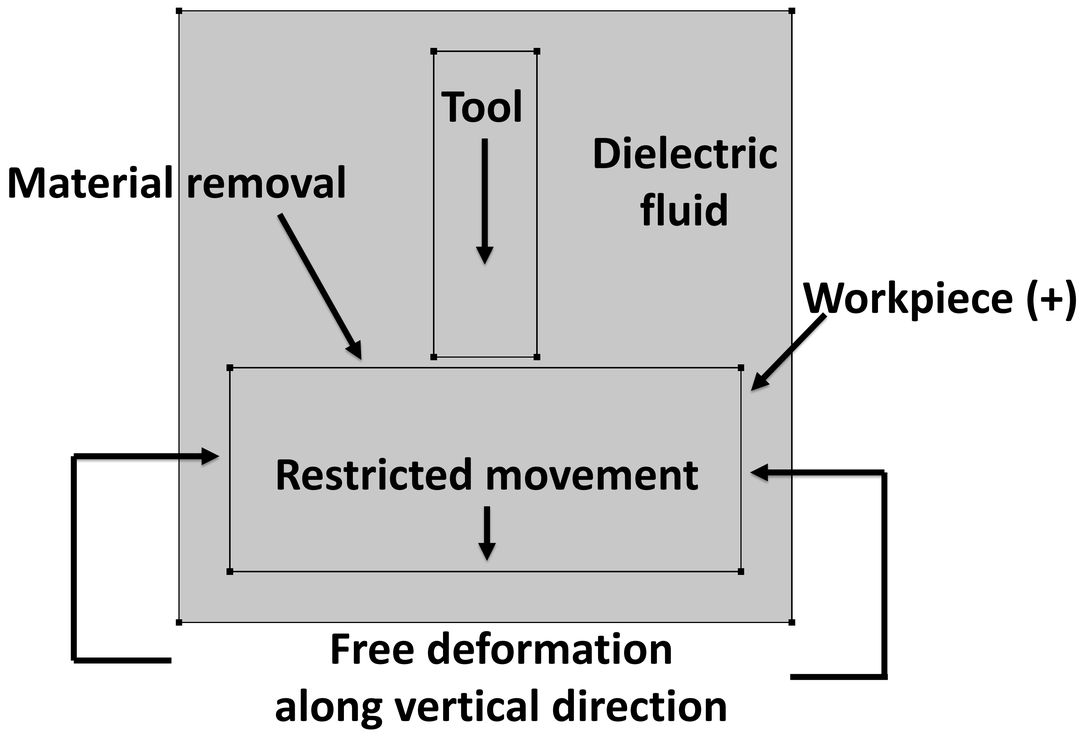

Figure 2. Model Geometry with boundary conditions

Results: Simulation of material removal using pulsed electric field showed good results (Fig.3) and this approach can very well simulate the MEDM material removal process for a constant heat source. Maximum electric field strength and minimum mesh quality during simulation are shown in Table 1.

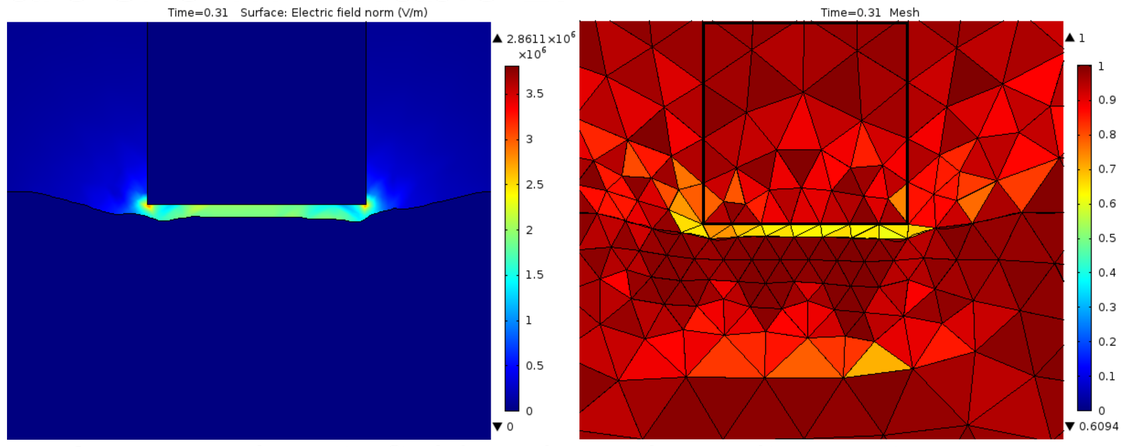

Figure 3. Electric field and Mesh quality at time *t=0.31* seconds

Time (secs)	Electric field strength (max) (MV/m)	Mesh quality (min)
0	7.0556	0.7311
0.1	5.2114	0.7033
0.20	3.3478	0.6681
0.31	2.8611	0.6094
0.41	3.8	0.5171
0.5	2.4127	0.422

Table 1. Electric field variation and mesh quality with time

Conclusions: A pulsed electric field based material removal has the advantage of locating the minimum gap and hence no additional algorithm need to be added to find out location of material removal. Moreover, coupling electric field with heat transfer and mapping the temperature can further enhance the understanding of the actual erosion process.

References:

1. Allen, P., Chen, X., ‘Process simulation of micro electro-discharge machining on molybdenum’, JMPT, 186, 1–3, 346–355, 2007