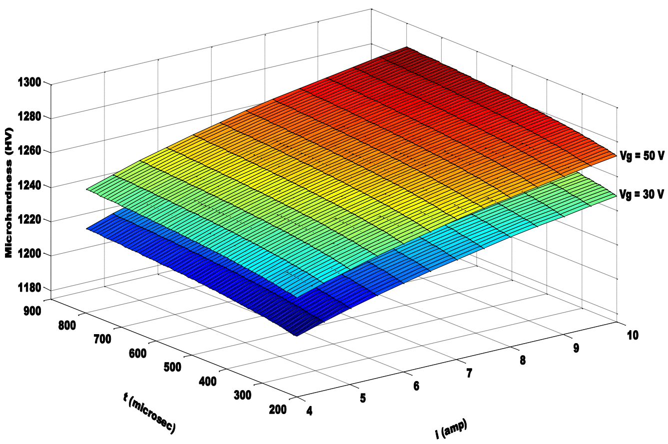

Figure 6: Variation of microhardness with process parameters for positive polarity copper tool

During the micro examination of the transverse section of spark machined samples, it clearly shows variation in microstructure from edge to the depth in form of recast layer along with cracks. During machining process, the material erosion observes owing to melting and evaporation however the entire the melted metal cannot be removed from sparking zone by the dielectric flushing system. Therefore, the remaining portion of the melted metal resolidifies rapidly on the machining area. This resolidified layer is termed as white layer which is reasonably different from the parent material. In this white layer various cracks, stress etc. are observed. These defects also degrade overall mechanical properties of the components. In white layer martensite phase generate which is relatively hard and non-etchable. After the white layer, there is another layer is observed known as heat-affected zone or dark band (refer **Fig. 5**.). In this region spark energy is insufficient to melting and vaporize but high enough to micro-structural transformations. Hence, formation of white layer, dark band and plastic deformation results change in micro-hardness. **Fig. 6.** illustrates increase in EDM process parameters result increase in micro-hardness. This formation of white layer increases with respect to spark energy due to improvement of process parameters. This white layer results increase in micro-hardness with process parameters.

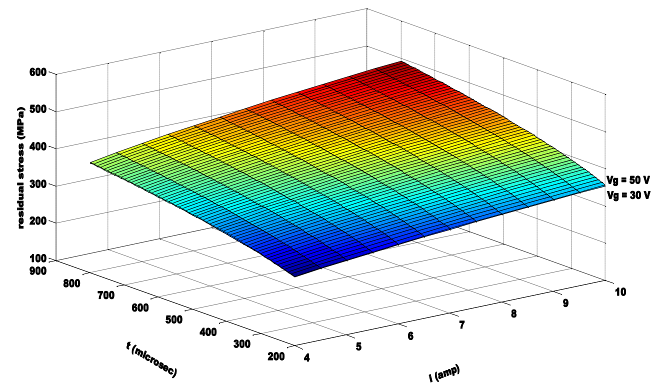

Figure 7: Variation of residual stress with process parameters for positive polarity copper tool

In this experiment, **Fig. 7** shows the high tensile residual stress are generated on machined sample. Typically, these tensile residual stresses are formed in the upper edge due to expansion and contraction of material occurs in the surface layer whereas the bulk material is not affected by the temperature gradient. The carbon content comes from the die-electric affects the variation of surface layer. While the tensile residual stress of machined sample is more as compared to the material's ultimate tensile strength, cracks are formed and distributed in white layer of machined sample. Therefore, the induced tensile residual stress increases with all these EDM process parameters because of high intensity of spark energy. This spark energy causes induction of tensile stress.

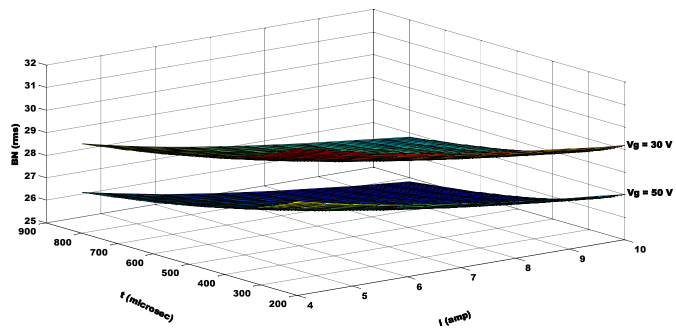

Figure 8: Variation of Barkhausen noise (rms) with process parameters for positive polarity copper tool

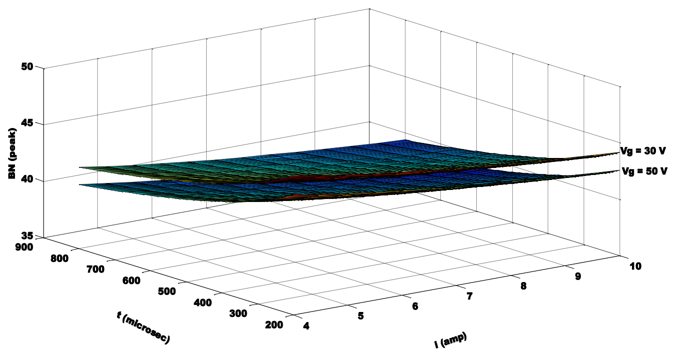

Figure 9: Variation of Barkhausen noise (peak) process parameters for positive polarity copper tool

Fig. 8 depicts the variation of rms value of BN signal with process parameters like I_p, T_{on} and voltage. From the experimental study, it was observed that the rms value of BN signal nonlinearly decreases with increases of all process parameters. As discussed in previous analysis, the MRR improves with all process parameters. During machining, the MRR results thermal damage of the EDMed surface and it may induce high tensile residual stress. Although MRR shows linear relation with all process but the inverse relation is observed among the rms value of BN signal and process parameters. Generally, BN signal is expressed by rms and peak value. But the rms value is more well-known parameter as compared to peak value. On the contrary, the peak value of BN signal decreases with increase of process parameters is depicted in **Fig. 9.** BN parameters are responsive of residual stress, plastic deformation as well as hardness. Typically, the tensile residual stress induced in workpiece is the source of large amplitude of BN signal. The greater the value of hardness leads to decrease rms and peak value of BN signal. In EDM process higher value of process parameters like I_p, T_{on} and voltage, results drastic fall of rms and peak value of BN signal through the entire experiment of present study. The higher value of micro-hardness generated on machined surface, provide better result in comparison to induced tensile residual stress.

CONCLUSIONS

From this present experimental work, the following conclusions may be drawn:

i. The MRR, TW and surface integrity during EDM significantly increases by process parameters due to more spark energy act on the workpiece surface.

iii. The induced tensile residual stress increases with all EDM process parameters because of high intensity of spark energy. This spark energy causes induction of tensile stress.

iv. Both rms and peak value of BN signal increases with decrease of EDM process parameters such as Ip, Ton and Voltage.

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