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STUDY ON RECENT DEVELOPMENTS AND RESEARCH ISSUES IN MICRO-EDM

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ABSTRACT

Due to better surface quality and greater precision that it can provide, EDM is an essential method for fabrication of micro components, micro tools and micro features. However several problems remain to be resolved before micro EDM can become a liable method with repeatable outcomes and its complete abilities as a micro manufacturing technique can be realized. This study presents on the scheduling of EDM method and wear issue of electrode. Special attention is paid to procedures and factors impacting the accomplished accuracy involving positioning approaches during grinding of electrode and EDM.

Keywords: Micro-EDM, Recent developments, Research issues

Introduction:

The process of EDM is based on thermoelectric energy made between an electrode and a work-piece submerged in a dielectric fluid. When the electrode and the work piece are isolated by a particular little gap the so known spark gap, a pulsed discharge exists which eliminate material from work piece through evaporation and melting. Presently several EDM developments have concentrated on the micro features production. This has become feasible due to accessibility of new CNC systems and advanced spark generators that have helped to develop quality of machinery surface. Also little method compel and better repeatability of the method outcomes have made micro EDM the best ways for accomplishing greater aspect ratio micro characteristics. Present micro EDM technique utilized for micro features of manufacturing can be classified into 4 varied groups:

1) Micro wire EDM where a diameter-wire is reduced to 0.02 millimeter is utilized to cut through a conductive work piece.
2) Micro EDM drilling where micro electrodes are utilized to drill work piece small holes.

3) Die sinking micro EDM where micro features electrode is engaged to generate its mirror identity in work piece.
4) Milling of micro EDM where micro electrodes are engaged to generate three dimensional cavities by acquiring a movement strategy common to that in conventional milling.

Despite the number of issuing praising the developed abilities of these methods still they are not utilized vastly. This is primarily due to the fact that accessible process and tools of machine are not reliable adequately. This study explains the major issues limiting the micro EDM application and provides certain solutions.

Problems of micro EDM:

This part argues the above described 4 kinds of applications of micro EDM and recognizes difficult areas with those applications. Product miniaturization needs a new process to operate design. Because so far micro EDM has tended to be carried out using conventional machines of EDM changed to accommodate the micro manufacturing needs several issues have emerged.

Management of electrodes and its parts:

In machines of wire EDM the trend to decrease the wire diameter utilized has affected numerous issues with managing electrodes and its parts. Initially already occurring machines of wire were acquired to take little diameter wires but this requested essential time for preparation of machine. From the spool place to nozzle of threading the distance was big and affected a big inconvenience deal for wire installation. The brakes dynamic forces could not be acquired simply by fine wire. This ensued in frequent breaks in wire which needed manual involvement. In die sinking of micro EDM milling or drilling varied devices and technologies can be engaged to support manipulating and handling little parts and electrodes. Therefore sub systems are including into machines of micro EDM for manufacture of on the machine and holding of the needed micro electrodes. The most

similar subsystems are dressing units and ceramic guides such as WEDG (wire electro discharge grinders).

Preparation of work piece and electrode:

The major problems in preparation of work piece common to the small holes production utilized for wire threading into the work piece. These holes could have micro diameters with a greater aspect ratio relying on the file to be machined. Generally they are generated either by EDM drilling or drilling. The holes positioning accuracy with respect to estimating point must be greater this is to simplify the procedure of automatic threading and to avoid short circuiting after threading although automatic threading through such holes on specialized machines of micro wire is critical. When micro features die sinking is needed more than one electrodes is generated in progress generally either by EDM or micro milling. Thus the size of feature is reduced further which may affect form distortion making geometry unmanageable. Such three dimensional profile electrodes production is time consuming and expensive. Trajectory EDM utilizes a easy shaped tube, electrode or rod of diameter between 0.1 and 0.4 milli-meter. The electrode can be EDM ground if a little diameter is needed. To avoid managing error stack up and difficulties when the electrode is externally manufactured to EDM machine extra devices are utilized to prepare the electrode on machine. The operating electrode is dissolved against a sacrificial electrode in an operation referred as grinding of EDM.

Process of EDM:

For micro EDM process planning must be regarded carefully as sizes of feature are little and so are the machined surfaced tolerances. During the process of machining and stage of preparation several mistakes exists which may lead to failed outcomes. These mistakes are because of imperfection equipment on one side and stochastic sparking process nature on the other side. Several papers aim ways of rewriting performance of EDM like the MRR (material removal rate), SQ (surface quality) and TWR (tool wear rate) [3]. For micro EDM the parameters of process are still at

the stage of development and their impacts on measures of performance have yet to be clarified. The parameters optimization is based on analysis of process to show the impact of every process variable on the desired machining features [3]. Despite the utilization of greater extent of automation of EDM machines and CNC controllers still there is lack of CAM components to assist micro EDM. One of the major issues for the restricted micro EDM milling application to complex three dimensional cavities machining is the difficulty of producing paths of tools using existing systems of CAM. Specifically those systems do not allow wear compensation of electrode nor assist difference of slice thickness or permit the cut direction to differ with every slice.

Measurement:

Measuring the surface quality dimensions of micro characteristics is not a simple activity. There are not even authorized processes of deciding the roughness of surface which is one of the most essential features for micro tooling. Evaluation of heat affected zone and recast layer which influence the machined surface properties needs specialized equipment [4]. On the machine estimation of feature dimensions and electrode is essential to accomplish better accuracy in micro EDM.

Errors of machine:

Repeatability and accuracy of positioning:

The repeatability and accuracy of machine positioning engaged is a major error source. The repeatability and accuracy of micro EDM die sinking machine positioning was estimated according to ISO 230-2-1997 using a laser interferometer. To machine a micro hole at particular place numerous dressed electrodes might be needed and therefore the machine positioning accuracy will primarily influence the hole position while the continuous positioning will influence on the shape and size of the hole.

Evaluating errors of cycle:

When electrical contact exists between the work piece and electrode a contact signal is recorded by the processor of machine

system during the establishment of work piece. The processor has fixed priorities in verifying every signal of machine status which refers that the contact signal checking is not undertaken regularly. Generally the signal of contact is verified every two to five minutes. Evidently to reduce the speed the speed must be as reduced as feasible but greater enough to avoid stick slip. The voltage is used between the spindle and table during the measuring cycle. The machine moves until contact of electric is made. The measurement accuracy is relied on the approach speed to the surface of work piece.

Error of temperature instability:

The alterations in room temperature and in structure of machine affect differences in relative position between the machine table and rotating head and therefore influence the dressing unit position with respect to machine zero point and electrode. The evident way to reduce those differences is to operate in a temperature controlled room and to assure machine structure thermal stability. Every machine must be verified to set up the machine temperature time to stabilize for some ambient situations and the deviations related to temperature of every axis must be estimated to schedule dressing of electrode with reduced error.

Spark gaps:

The selection of pulse parameters is linked directly with the surface roughness and removal rate needed in conventional EDM. Electrode wear is another essential criterion which required to be regarded carefully in micro EDM. In order to accomplish micro characteristics the spark gap must be little. The parameters of pulse are chosen relying on the roughness of surface needed and on the dressing speed. Because the electrode is revolving its roughness surface must not impact the machined surfaces roughness essentially. However due to little dimensions included greater extent of roughness will influence the dressed electrodes strength which could break during the method.

Fixtures and jigs:

The most familiar device for owning the big thin WC electrode is a ceramic guide. The

differences in effective diameter can exist which reflects the electrode tolerance and the conditions of assembly between the ceramic guide and electrode. The maximum difference can exist when the electrode position within the guide shifts to numerous extreme points. This is feasible only when there is essential electrode movement along the axes common to the guide.

Wear of electrode:

Wear of electrode is not a major issue for micro wire EDM apart from the fact that a greater wear rate might affect much frequent breaks of wire. This is because of the fact that wear lowers the micro wire cross section and therefore the expanded tension the wire can acquire drops essentially. Electrode wear becomes an essential problem when engaging macro and micro features electrodes on an individual electrode will implement varied ratios of wear. The area of sparking will alter as the electrode moves down which will bring varied conditions of sparking during the method and will lower quality. There are issues when generating blind holes because wear lowers the electrode length constantly in micro EDM drilling. As an outcome when eroding down to a constant depth the actual hole depth will be little essentially. One solution is to repeat the method several times with reground or new micro electrodes until the needed profile is acquired. This is known as strategy of multiple electrode. The major obstacle is that it can be difficult and time consuming to find the number of required electrodes. A basic process is to utilize a strategy of layer by layer machining that compensates for wear during every layer machining by steady feeding of electrode in the axis. In the UWM (uniform wear method) the electrode path is designed specially to assure that after every layer machining the actual electrode shape is stored again. This is performed using an integration of carefully configured paths of overlapping tool and thickness of small layer. According to Yu [7] uniform wear method includes a time consuming empirical process for choosing tool paths. These tool paths design derives from cross section area value of electrode the layer surface area, the cut depth and ratio of volumetric wear

which are regarded to be steady. As the sparking situations and therefore the volumetric wear might not be steady during the process of erosion another kind of compensation process has been suggested which is based on supervision of sparking situations during the process to evaluate the wear on line using a mathematical model of sparking effectiveness. Such a process has been regarded for conventional EDM [8, 9]. In this study an easy process based on strategy of multiple electrode is suggested which can provide a good level of accuracy and repetability. If electrode dressing is carried out at the initiation of a path the remaining dressed electrode length must be long enough at least common to cavity's depth to avoid erosion with undressed electrode path. The major obstacle of this process is the time wasted when an electrode follows a path eroded already. However to lower the electrodes number that might be required to finish a cavity every path must be designed specially to optimize the material removal.

Conclusion:

This study has given a summary of major problems influencing the performance and restricting the micro EDM application. The presented outcomes can help to schedule the process within expected tolerances. When allocating tolerances of process for micro EDM entire process aspects such as kind of electrode grinding, kind of positioning and operation duration must be regarded. All these activities will accumulate mistakes which must be considered into account. The overall efficiency of machining relies on a complex rapport between varied parameters of process and their optimization is based primarily on empirical methods. To remain rivalry as micro manufacturing technique processes of micro EDM must utilize reliable strategies and algorithms with continuous outcomes. The suggested micro milling strategy replaces complicate evaluations of existing processes with easy measurement of length. This must make new strategy attractive to industry.

References:

[1] D. Dauw, On the derivation and application of a real time tool wear

sensor in EDM, Ann. CIRP 35 (1) (1986) 111–116. http://dx.doi.org/10.1016/S0007-8506(07)61850-2

[2] H.S. Lim, Y.S. Wong, M. Raham, E.M.K. Lee, A study on the machining of high-aspect ratio micro-structures using micro EDM, J. Mater. Process. Technol. 140 (2003) 318–325. http://dx.doi.org/10.1016/S0924-0136(03)00760-X

[3] J.D. Ayers, K. Moore, Formation of metal carbide powder by spark machining of reactive metals, Metal. Trans. A 15 (1984) 1117–1127. http://dx.doi.org/10.1007/BF02644706

[4] K.H. Ho, S.T. Newman, State of the art electrical discharge machining EDM, Int. J. Mach. Tools Manuf. 43 (2003) 1287–1300. http://dx.doi.org/10.1016/S0890-6955(03)00162-7

[5] N. Mohri, M. Suzuki, M. Furuya, N. Saito, Electrode wear process in electrical discharge machining, Ann. CIRP 44 (1) (1995) 165–168. http://dx.doi.org/10.1016/S0007-8506(07)62298-7

[6] P. Bleys, J.P. Kruth, B. Lauwers, A. Zryd, R. Delpretti, C. Tricarico, Real time tool wear compensation in milling EDM, Ann. CIRP 51 (1) (2002) 157–160. http://dx.doi.org/10.1016/S0007-8506(07)61489-9

[7] S. Dimov, D.T. Pham, A. Ivanov, K. Popov, CAM system for layer based EDM, Int. J. Manuf. Sci. Prod. 5 (1–2) (2003).

[8] W. Meeusen, D. Reynaerts, H. Van Brussel, A CAD tool for the design and manufacturing of freeform micro EDM electrodes, Proc. SPIE 4755 (2002) 105–113. http://dx.doi.org/10.1117/12.462800

[9] Z. Yu, T. Masuzawa, M. Fujino, 3D micro-EDM with simple shape electrode, Int. J. Electr. Mach. 3 (1998) 7–12 & 71–79.

[10] Z. Yu, T. Masuzawa, M. Fujino, Micro-EDM for three-dimensional cavities—development of uniform wear method, Ann. CIRP 47 (1) (1998) 169–172. http://dx.doi.org/10.1016/S0007-8506(07)62810-8

[11] Z.Y. Yu, J. Kozak, K.P. Rajurkar, Modelling and simulation of micro EDM process, CIRP Ann. Manuf. Technol. 52 (1) (2003) 143–146. http://dx.doi.org/10.1016/S0007-8506(07)60551-4

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