International Journal of Engineering Research
Volume No.6, Issue No.5, pp :239-241
ISSN:2319-6890 (online),2347-5013(print)
1 May 2017

A Review on Recent Advancement of Micro Electrical Discharge Machining

Binayaka Nahak
Department of Mechanical Engineering, I.I.T., B.H.U. Varanasi U.P., INDIA
binayakanahak@gmail.com

Abstract- The requirement of microstructure products has shown consistency growth in recent years. Micro EDM (µEDM) is non traditional machining process used for manufacture of micro-components because of its the high precision, low tolerance and improved surface structure. It is a thermoelectric process in which mechanism of material erosion of work-piece is based melting and vaporization of material. This method is used to manufacture micro-parts with the range of 50 µm -100 µm.. At least twenty papers were briefed and the detail were classified into three major heading, namely micro EDM, micro drilling and micro EDM development. The three machining process explained in terms of improved machining process, application of various materials , fabrication of small feature size , high aspect ratio.

Keyword: Micro-EDM, Micro components, aspect ratio

I. Introduction

Micro Electrical Discharge Machining (µEDM) non-traditional machining process used for manufacturing of complex components with allowed value of tolerances. The basic theory of µEDM is same as that of the Electrical Discharge Machining. The material erosion of specimen is based on melting and vaporization between two electrical conductive electrodes. It is the cumulative result of several single discharges.

II. Micro Electrical Discharge Machining

Zhenyuan Jia et al.[1] developed three mapping method to represent a suitable classification of discharge pulse in µ EDM . They used three mapping functions are identified by different methods namely fuzzy recognition, LVQ neural network categorization and judging method. They also concluded signal based on voltage and current changes into discharging pulses using these mapping function. Lingxuan Zhang et al[2]. used signal distortion, type-2 fuzzy logic sets and high noise in µEDM process. In this work, the type-2 fuzzy control method is preferred due to its highest efficiency, more stable among type-1 fuzzy control and average voltage control. Z. Katz et al [3]. showed that discharge process is effected by electrode size because of the variation of the power supply field intensity in µEDM. Ornwasa Traisigkhachol et al. [4] developed an EDM tool micro electrode combining of n SU-8TM micro mold through electroplating. In addition, the elimination of resist residual from SU-8TM micro mold was observed. This concept was used to production of high aspect ratio micro components. Dong-Yea Sheu et al [5] presented a combined gluing as well as assembling
methods in µEDM for manufacturing of micro ball-ended spherical stylus tips. Sang Do Kwan Chung et al[6] discussed the use of higher frequency bipolar pulse generator in µEDM with water to avoid electrolytic corrosion. Therefore, to maintain the accuracy of micro components tap water is not preferred in µEDM. Do Kwan Chung et al.[7] revealed that a small positive pulse duration is supplied to the specimen to avoid the electrolytic corrosion for µEDM with deionized water as well as high frequency bipolar pulse. M.Murali et al [8] produce biocompatible micro device using µEDM. the total time for fabrication is very less, so it is suitable method for rapid fabrication of high precision prototype. This method is time saving method, less cost, small feature size and . It also reduce the surface roughness during specimen undergoes ultrasonic vibration. H.S.Lim et al.[9] revealed fabrication of micro-structures such as tool with high aspect ratio and work piece micrometer range using µEDM.

III. Micro Drilling

Min Yi et al[10]. noted the manufacturing of punch tools using tungsten carbide in µEDM. Muhammad Pervej Jahan et al.[11] established the comparative study of deep hole on two tungsten carbide composite and stainless steel using micro drilling. They concluded that micro hole observed in tungsten carbide composite shows better surface finish in comparison to stainless steel due to low thermal properties of steel. The higher value of discharge energy promotes more overcut of the microhole in stainless that that of WC-Co composite due to high thermal expansion coefficient of stainless steel. The taperness of microhole observed in WC-Co is more than stainless steel because of more electrode wear of drilling operation in tungsten carbide composite. Due to short circuit and arcing pulse are results degrade of surface quality and lower MRR. Due to more unstable machining process leads to long machining time results lower MRR in stainless steel than tungsten carbide composite. At high discharge energy and high aspect ratio, the EWR is more for machining of WC-Co than SUS 304 . Sang Min Yi et al.[12] revealed the use of micro

ISSN:2319-6890 (online),2347-5013(print)
1 May 2017

EDM to fabricate stainless steel shadow mask . Long Zhang et al. [13] integrated tangential-feed wire electro discharge and self-drilled holes method is used for correct and high effective machining in µEDM. This method progress the removal resolution and increase surface quality of micro electrode. G. D'Urso et al.[14] revealed the effect of performance in µEDM of various specimens with different tool electrode. They used the material technology indexes for the observation of process performance and geometrical .The assessment surface integrity was investigated on the micro holes fond in various conditions. Li Wei et al.[15] used interpolation method to improve machining of hard materials. This method is combination of three section namely interpolation method, variable period method and numerical control code storage approach .The new interpolation method avoid short circuit in µEDM milling and increase its efficiency . On the other hand numerical control code storage method decrease data volume and based on square constraints. The variable-period feed method also uses pulse power supply results increase the electrode feed rate efficiency.

IV. Micro EDM Development

Lingxuan Zhang et al. [16] developed a model for µEDM with the use of supporting vector machine. They also optimized the combined parameters that reduce the process time and EW. This method also increase the efficiency as well as stability of µEDM process. C.-L. Kuo et al.[17] fabricated 3D metal microstructures using a micro- EDM and Nd-YAG laser welding. This method is used to develop micro parts with small dimensions, high failure sensitivity, and micro-precision. Yang-Yang Hu et al.[18] described to manufacture higher aspect-ratio electrode array by the integrating of µEDM and UV-LIGA . Pun-Pang Shiu et al.[19] presented a technique to manufacture the metallic mold masters with the application of both micro electro discharge machining and laser technique. This technique shorten production downtime and reduce the cost per unit device. K.Takahata et al.[20] manufactured high aspect ratio WC-Co microstructure using combines LIGA and µEDM. This microstructure is high withstand to buckling and wear under service. In addition, it has high Youngs modulus and hardness. G. Girardin et al.[21] developed cylindrical microelectrode tools with high aspect ratio for µEDM. The tool fabrication is cheap and automated technique. Claudia Richter et al.[22] used the integrated µEDM and electrochemical polishing to manufacture 3D micro devices. This combined method improves the surface quality of manufactured 3D device. C.-L. Kuo et al.[23] fabricated a micro part using integrated µ-EDM and Nd-YAG laser method. This method provide high aspect ratio and good strength to this manufactured micro part. Zhaoqi Zeng et al.[24] manufactured 3D metallic micro-structures using integrated µEDM and µECM. The surface quality and mechanical property of the specimens are increased. The machining efficiency is increased because of high processing energy and high tool feed rate.

V. Conclusion

Now these days, µEDM processes have huge requirement for the development and improvement of various microstructure This paper summarized various advancement in the µEDM method over the last decades and established to be helpful for future research and progress. The result of this paper would help the researcher to think in different area as discussed in this paper such as to develop new experimental set up, experimental studies and optimization method, Therefore µEDM processes will continue for competition as a micro-manufacturing technology.

Acknowledgement

The authors gratefully acknowledge the support of Motilal Nehru National Institute of Technology-Allahabad, Uttarpradesh, India for funding .

References

i. *Zhenyuan Jia & Xinyi Zheng & Fuji Wang &Wei Liu & Ming Zhou "A progressive mapping method for classifying the discharging states in micro-electrical discharge machining " Int. J. Adv. Manuf. Technol. (2011) 56:197–204.*

ii. *Lingxuan Zhang & Zhenyuan Jia &Wei Liu & Anchao Li "A two-stage servo feed controller of micro-EDM based on interval type-2 fuzzy logic". Int. J. Adv. Manuf. Technol. (2012) 59:633–645.*

iii. *Z. Katz · C.J. Tibbles "Analysis of micro-scale EDM process" Int. J. Adv. Manuf. Technol. (2005) 25: 923–928.*

iv. *Ornwasa Traisigkhachol • Hermann Schmid • Marc Wurz • Hans H. Gatzen "Applying SU-8TM to the fabrication of micro electro discharge machining electrodes" Microsyst. Technol. (2010) 16:1445–1450.*

v. *Dong-Yea Sheu & Chung-Chieh Cheng "Assembling ball-ended styli for CMM's tactile probing heads on micro EDM" Int. J. Adv. Manuf. Technol. DOI 10.1007/s00170-012-4187-z.*

vi. *Do Kwan Chung, Hong Shik Shin, Min Soo Park and Chong Nam Chu "Machining Characteristics of Micro EDM in Water using High Frequency Bipolar Pulse" international journal of precision engineering and manufacturing (2011) 12(2): 195-201.*

vii. *Do Kwan Chung • Hong Shik Shin • Chong Nam Chu "Modeling and experimental investigation for electrolytic corrosion prevention in high frequency micro EDM using deionized water" Microsyst. Technol. (2012) 18:703–712.*

viii. *M.Murali and S.H .Yeo "Rapid Biocompatible Micro Device Fabrication by Micro Electro-Discharge Machining. Biomedical Microdevices" (2004) 6(1):41-45.*

ix. *H.S. Lim, Y.S. Wong, M. Rahman, M.K. Edwin Lee "A study on the machining of high-aspect ratio micro-structures using micro-EDM " Journal of Materials Processing Technology (2003)140:318–325.*

ISSN:2319-6890 (online),2347-5013(print)
1 May 2017

x. Sang Min Yi , Byung Yun Joo Min Soo Park Chong Nam Chu Soo-Ik Oh. "Mechanical punching of 15 lm size hole " Microsyst .Technol. (2006) 12: 877–882.

xi. Muhammad Pervej Jahan & Yoke San Wong & Mustafizur Rahman "A comparative experimental investigation of deep-hole micro-EDM drilling capability for cemented carbide (WC-Co) against austenitic stainless steel (SUS 304)" Int. J. Adv. Manuf. Technol. (2010) 46:1145–1160.

xii. Sang Min Yi Min Soo Park Young Soo Lee Chong Nam Chu "Fabrication of a stainless steel shadow mask using batch mode micro-EDM " Microsyst. Technol. (2008) 14:411–417.

xiii. Long Zhang, Hao Tong, Yong Li "Precision machining of micro tool electrodes in micro EDM for drilling array micro holes" Precision Engineering (2015) 39: 100–106.

xiv. G. D'Urso, C. Ravasio " Material-Technology Index to evaluate micro-EDM drilling process" Journal of Manufacturing Processes (2017) 26 :13–21.

xv. Li Wei & Lingxuan Zhang &Wei Liu & Zhenyuan Jia & Anchao Li "A new interpolation method of variable period and step size in micro-EDM milling based on square constraint" Int. .J Adv. Manuf. Technol. DOI 10.1007/s00170-012-3950-5.

xvi. Lingxuan Zhang & Zhenyuan Jia & Fuji Wang &Wei Liu "A hybrid model using supporting vector machine and multi-objective genetic algorithm for processing parameters optimization in micro-EDM " Int. J. Adv. Manuf. Technol. (2010) 51:575–586.

xvii. C.-L. Kuo, J.-D. Huang and H.-Y, Liang "Fabrication of 3D Metal Microstructures Using a Hybrid Process of Micro-EDM and Laser Assembly" Int. J. Adv. Manuf. Technol. (2003) 21:796–800.

xviii. Yang-Yang Hu D. Zhu Æ N. S. Qu Y. B. Zeng P. M. Ming "Fabrication of high-aspect-ratio electrode array by combining UV-LIGA with micro electro-discharge machining " Microsyst. Technol. (2009) 15:519–525.

xix. Pun-Pang Shiu • George K. Knopf • Mile Ostojic "Fabrication of metallic micro molds by laser and electro-discharge micromachining" Microsystem. Technol. (2010) 16:477–485.

xx. K.Takahata,N.Shibaike, H.Guckel "High aspect ratio WC-Co microstructure produced by the combination of LIGA and micro-EDM. Microsystem Technologies (2000) 6:175-178.

xxi. G. Girardin, Y. Layouni, P. Morin, M. Cabrera "Micro EDM with the in situ electrochemical fabrication and regeneration of the tungsten microelectrode tool" Int. J. Mater. Form (2010) 3 (1):1083 – 1086.

xxii. Claudia Richter • Thomas Krah • Stephanus Bu¨ttgenbach "Novel 3D manufacturing method combining microelectrial discharge machining and electrochemical polishing" Microsyst. Technol. DOI 10.1007/s00542-012-1452.

xxiii. C.-L. Kuo, J.-D. Huang and H.-Y. Liang "Precise Micro-Assembly Through an Integration of Micro-EDM and Nd-YAG " Int. J. Adv. Manuf. Technol. (2002) 20:454–458.

xxiv. XIV. Zhaoqi Zeng, Yukui Wang, Zhenlong Wang, Debin Shan, Xiaolong He "A study of micro-EDM and micro-ECM combined milling for 3D metallic micro-structures" Precision Engineering (2012) 36:500– 509.