Measurement Analysis in Electrochemical Discharge Machining (ECDM) Process: A Literature Review

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Abstract: Electrochemical discharge machining is considered to be a hybrid machining process that combines with EDM and ECM (electro chemical machining), called ECDM. The material removal is based on two phenomena: electrochemical dissolution of the material and thermal erosion of electrical discharges that occur between the cathode & anode electrodes. This process is better used for machining of non conducting materials efficiently. In this research paper shows that a brief literature review study of various measuring instruments used for analysis of various parameters of the electrochemical discharge machining process on various types of materials, tool material, input & output parameters such as surface roughness, surface texture, material removal, tool wear etc..

Key words: ECDM, SEM (scanning electron microscope), oscilloscope.

1. Introduction

Measuring tools used in ECDM (electrochemical discharge machining) machining process such as SEM (scanning electron microscope), optical microscope, AFM (atomic force microscope), Oscilloscope, pyrometer for measuring parameters of micro components such as surface roughness, surface texture, current voltage waveforms, temperature etc.

2. SEM (Scanning Electron Microscope)

One of the primary tools used for analysis of micro & nano images is SEM. A electron microscope in which the surface of a specimen is scanned by a beam of electrons that are reflected to form an image.

2.1 Creator & Debris

J. W. Liu et al. has studied for ECDM machining used to machine MMC (metal matrix composites) material Craters & debris produced in the processing condition emulsion medium was used and the spark gap size was 5 mm. Materials are found out of magnification was X100 & area 100 µm as shown in Fig. 1 [1].

2.2 Micro Hole

A. Ravi Sankar et al. analyzed Circular hole micro-machined using the 45% NaOH solution as an electrolyte micro-machined hole is around 450 µm. Magnification X60 & Area of 200 µm [2]. Margareta Coteaţa et al. also produced micro hole measured using (SEM) (Hitachi S-4800) top side hole and sectional view of the hole taking X120 400 µm as shown in Fig. 2 [3].

2.3 Tool Wear

Margareta Coteaţa et al. measured wear of the electrode tool using SEM obtained magnification of X300 & area of 100 µm [3]. Cheng-Kuang Yang measured Geometrical dimensions of micro-tool electrodes micro-holes machined by different tool electrodes, different machining depth and cross-section profile of through holes [4]. C. T. Yang et al. found out using SEM micrographs of slit given different wire tensions 4 & 8N. Fig. 3 shows SEM micrographs of the surface at different abrasive concentrations pure electrolyte, concentration 100 g/L & 300 g/L, surface at different power frequencies, 40, 67 and 100 Hz [5].
2.4 Micro Channel

V. K. Jain et al. measured micro channel using SEM image of micro-machined channel depth of 1,348.07 μm, width of 643.41 μm, aspect ratio of 2.1, Fig. 4 shows that shadowgraph sketch of a micro-channel and heat affected zone [6].

2.5 Micro Groove

Zhi-Ping Zheng et al. have produced a machined microgroove in a Pyrex glass with a cylindrical tool of 200 μm diameter. Using SEM found out the surface structure of the machining area of micro groove shown in Fig. 5 [7].

2.5 Grinding Effect of ECDM

J. W. Liu et al. have measured grinding effect of ECDM. In that machined surfaces a with grinding effect under a single pulse processing condition parameters are such as electrolyte concentration 2.5 weight%, applied voltage 90 V, pulse duration 200 μs, duty cycle 1:7, spindle speed 15,000 RPM & workpiece material was taken as 10 AIO composite, 10 AIO and 20 AIO. The SEM micrographs show the crater distribution on the MMC surfaces after by G-ECDM as shown in Fig. 6 [8].
3. XRD Analyser

J. W. Liu et al. used XRD Analyser for analysis of the phases of the EDM and ECDM specimens shown in Fig. 7 [1].

4. Oscilloscope

J. W. Liu et al. used oscilloscope for measurement of ECDM machined affecting various parameters such as current, duty cycle, pulse duration, electrolyte concentration [1]. M. Schopf et al. found out ECM phases have to be combined with EDM phases. Using oscilloscope measured voltage and current waveforms during ECDM process [9]. V. Raghuram et al. have also used oscilloscope for analyzing the average current and voltage were recorded on a potentiometric strip chart recorder with the help of a calibrated resistance network. For that purpose oscilloscope (DSS 2011 Kikusui, Japan) & Oscillographic Recorder (8801 Hioki, Japan) were used [10]. Anjali V. Kulkarni has developed the concept of measurement of ECDM process parameters such that synchronised time-varying current and temperature for the copper workpiece. For analysis of Pyrometer temperature transients and current transients are measured and stored using KIKUSUI 60 MHz, 4 channel digital storage oscilloscope was used [11]. Cheng-Kuang Yang has used a LeCroy 422 & 200 MHz two-channel digital storage oscilloscope for measurement of the current signal and discharge frequency in ECDM machining process [4].

5. Optical Microscope

A. Kulkarni et al. have taken borosilicate glass used as the material to be machined. For surface feature analysis, it is used under such condition of no discharge striking the work-piece surface. The optical microscope was used for analyzing surface feature of machined area with the respective parameters of copper & Tantalum tool material, voltage, concentration of the electrolyte under magnification of 100X & 200X shown in Fig. 9 [12]. C. T. Yang et al. have obtained groove shapes using different work-piece feeding mechanism, discharge the current response, different electrolytes such as NaOH & KOH were used. Optical microscope micrographs were used for analyzing surface structure [5].

6. AFM (Atomic Force Microscopy)

A. Ravi Sankar et al. have measured surface roughness of coupled effects of an electroplated gold layer plate using AFM, this plate is further used for micomachined by using ECDM process. The
deposition rate and the mean surface roughness of the plated gold layer of thickness around 20 μm were found to be around 6.5 μm/h and 2 nm respectively at a current density of 3.5 mA/cm² shown in Fig. 10 [2].

7. Digital Microscope

M. Coteata et al. have used digital microscope for measurement of micro-cavities observed on the lateral side of the electrode. The initial diameter of the electrode tool was 0.5 mm and measuring tool wear of the electrode after machining process [13].

8. Surface Topography

M. Schopf et al. have found out the efficiency and accuracy of new ECDM technology i.e., ECDM trueing and dressing. Surface quality and roundness of grinding wheel & work-pieces are analyzed. For measurement of surface topography of metal bonded grinding wheel D46 C75 used a tactile surface measuring instrument Form Talysurf Series 2 of Taylor Hobson was used [9].

9. Pyrometer

Anjali V. Kulkarni has measured during ECDM process there is producing high temperature to sense the high, transient temperature of the localized zone on the work-piece surface where discharge strikes, a pyrometer is used. For that purpose Pyrometer model D-7441, Kohelberg, with sensing temperature ranges of 815-1, 700 °C measures the temperature in a non-intrusive way [11].

10. Microbalance

S. Tandon et al. Material removal from the work-piece and the tool was measured by a microbalance with accuracy of $1 \times 10^{-5}$ g. In this case, work piece material was taken as glass-epoxy composite specimen [14].

11. Conclusions

(1) This paper shows that measuring equipments used in this machining process for analysis of output parameters;
(2) It shows that different equipment used for different purpose;
(3) Every measuring equipments show key role in analysis specially Scanning Electron Microscope gives the exact values of machined surface images in precise manner.

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References


