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DETERMINATION OF SURFACE CHARACTERSTICS ON MICRO-EDM DRILLING PROCESS OVER TITANIUM MATERIAL

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ABSTRACT

Micro-EDM is a process based on the thermoelectric energy between the workpiece and an electrode. Micro-EDM is a newly developed method to produce micro-parts which in the range of 50 μm -100 μm. Micro-EDM is an efficient machining process for the fabrication of a micro-metal hole with various advantages resulting from its characteristics of non-contact and thermal process. Micro Electro Discharge Machining Drill is variant EDM processes in a situation where it employs water as a dielectric fluid, with pressure flushing and rotating nanotube electrode. A pulse discharges occur in a small gap between the work piece and the electrode and at the same time removes the unwanted material from the parent metal through the process of melting and vaporization. The material selected is Titanium to study the SEM microstructure by varying the process parameters of machining in micro EDM. The scanning electron microscope (SEM) is a type of electron microscope that produces images of a sample by scanning the surface with a focused beam of electrons. The electrons interact with atoms in the sample, producing various signals that contain information about the surface topography. The electron beam is scanned in a raster scan pattern, and the position of the beam is combined with the detected signal to produce an image. SEM can achieve resolution better than 1 nanometer. Specimens are observed in high vacuum in conventional SEM. The most common SEM mode is the detection of secondary electrons emitted by atoms excited by the electron beam. The number of secondary electrons that can be detected depends, among other things, on specimen topography. Scanning the sample and collecting the secondary electrons that are emitted using a special detector, an image displaying the topography of the surface is created.

Keywords: Micro Electro Discharge Machining Drill (Micro EDMD), Titanium, MRR, SEM

1. INTRODUCTION

Miniaturization of parts and components play an important role in the development of today's and future's sophisticated technology in various fields. With the increasing demand for micro parts and structures in many industries, and also with rapid developments in micro-electro-mechanical systems (MEMS), micro manufacturing techniques for producing these parts become increasingly important. Micromachining is a key process for manufacturing of micro components. Micro Electric Discharge Machining (micro-EDM) is one of the most efficient techniques to produce micro/mini components and parts. With the newest high precision micro-EDM tool, product

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family of micro-EDM is expanding with the precious components of such devices as; accelerometers, force-balanced transducers, fiber-optic & light detector fixturing, micro-shafts, gears, micro-molds and dies. Micro-holes, micro nozzles and micro slots are widely used micro shapes. Especially micro-holes have wide range of application areas such as nozzle for diesel injectors including holes of Ø 0.10 mm with a depth of 0.7 mm (Figure 1.1-a), surgical needles (Figure 1.1-b), implants, surgical precise and fine instruments and intra-ocular lenses.

Figure 1.1: (a) Nozzle for diesel injectors, (b) surgical needles.

2. METHODOLOGY

2.1 Micro Electric Discharge Machine

Fig 2.1 : MicroEDM Drilling (Rapid Drill)

2.2 Features of Rapid Drill

The following are the features of rapid drilling: smart hole drilling in hard metals, Both brass and copper electrode tubes can be used, Large drilling range, Tap water is used as dielectric fluid, Granite work table ensures long life, Precision DC servo control to maximize drilling stability and speed Compact foot print

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Table 2.1 Technical Specifications

Machine Tool	Rapidrill II
Work table	450 x 300 mm (graphite)
X & Y axis travel	350, 250 mm
Z axis travel	350 + 300 mm
Max , electrode length	400 mm
Size of electrode dia	Ø 0.3 – 3.0 mm
Max, drill depth	≥ 300 mm
Max, coolant pressure	6 Mpa
Max, weigh of the workpiece	350kg
Connected load	3 KVA
Work tank	25 L
Input power supply	3 Phase, AC 415 V* 50Hz
Net weight	750 kg
Machine foot print	950 x 850 x 1980mm
Max, machine current	

Table 2.2 Technology of Rapid Drill

Job material	Steel/ Carbide/ Other conducting materials
Dielectric	Tap water / Coolant Soap
Max, drilling Speed	20 – 60 mm/ min (dia1.0 mm)

Table 2.3 Definition of input and output parameters

Parameter	Symbol	Unit	Definition
On-time	T	Ms	Duration of each spark
Off-time	P	Ms	Pause time between two sparks
Peak current	I	A	Maximum current during spark
Voltage	U	V	Voltage between gap just before spark
Compression	COMP	Mm	Distance between electrode and workpiece

3. RESULTS & DISCUSSION

3.1 Surface Characteristics after Machining

Fig 3.1(a) Shows various graphite structures with maximum of white layers and at one particular layer there is a tail like structure attached to the white layer.

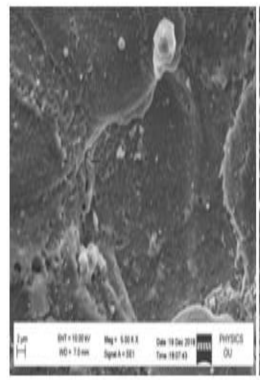

Figure 3.1(a) Sem image of Sample 1A

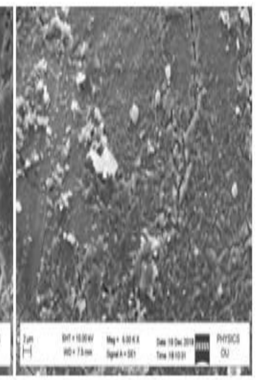

Figure 3.1(b) SEM image of Sample 1B

Fig 3.1(b) Spearingly there is a deposit of carbon but clearly there is a visible of cracks at various magnifications of the structure and deposits of cotton layers or waste cotton.

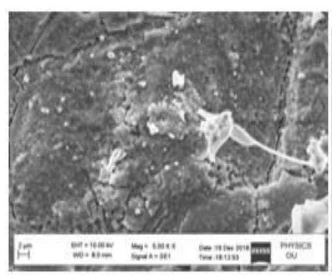

Figure 3.1(c) SEM image of Sample 1C

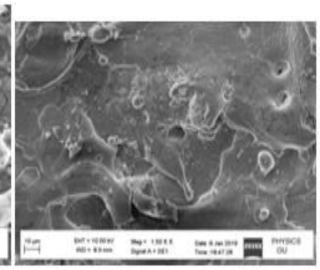

Figure 3.2(a) SEM image of Sample 2A

Fig 3.1(c) Shows there is a more crack appearance compared to fig 3.1(b) with white layer deposited on the surface and less carbon percentage of deposit.

3.2 Spectrum location in the Titanium Specimens after Machining by MEDM

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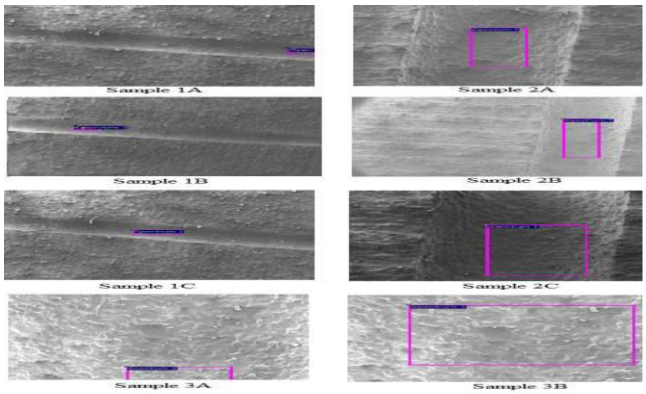
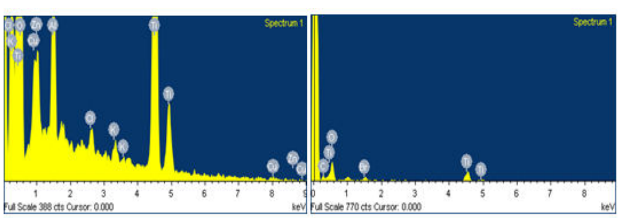


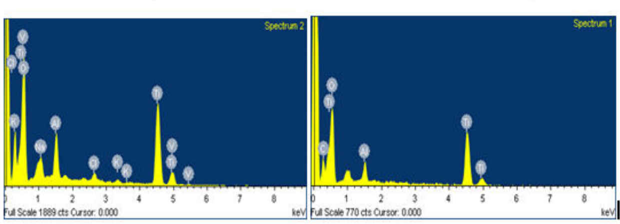
Figure 3.3 Spectrum location of the samples for EDAX

SAMPLE NO	Weight percentage								
	Carbon (c)	Oxygen (o)	Aluminium (Al)	Titanium (Ti)	Copper (cu)	Chlorine (cl)	Potassium (k)	Sodium (Na)	Vanadium (v)
1A	-	36.52	3.91	51.09	-	0.96	0.88	-	-
1B	-	41.11	4.12	48.52	-	1.31	0.81	1.1	2.71
1C	-	36.04	3.55	51.83	3.51	0.78	0.55	1.34	2.40
2A	-	34.46	2.79	62.74	-	-	-	-	-
2B	5.39	38.38	-	53.36	-	-	-	-	2.87
2C	11.22	39.25	2.42	47.12	-	-	-	-	-
3A	-	67.40	-	32.60	-	-	-	-	-
3B	23.18	38.32	4.24	28.49	5.78	-	-	-	-

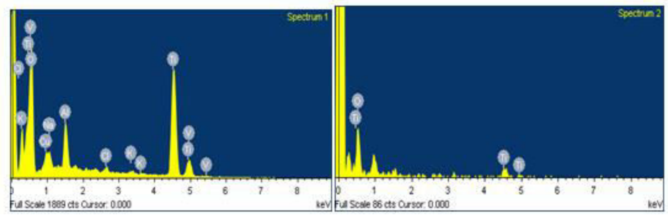
Table 3.1 Chemical composition of specimen after machining



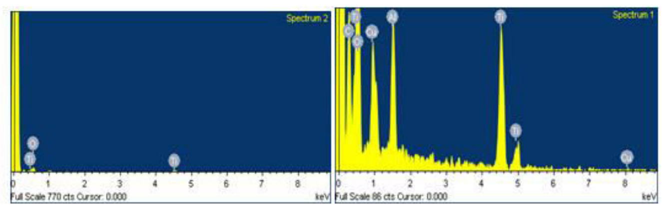
Sample 1A **Sample 2B**



Sample 1B **Sample 2C**



Sample 1C **Sample 3A**



Sample 2C **Sample 3B**

Figure 3.4 Graphs of Element weight Percentage in Specimens after Machining

4. CONCLUSION

- The SEM analysis shows various structures in Fig 6.1 (a), (b) and (c) (samples 1A, 1B & 1C) and Fig 6.2 (a), (b) and (c) (samples 2A, 2B & 2C) which is gives detail study of the Titanium at the magnification of 1..50kk with 10µm length and width of 7.00 mm shows better structure and crack appearance.
- Micro EDM Drill has considerably lower erosion charge for drilling micro holes.
- The Titanium leads erosion rates of high thermal also electrical conductive.
- EDAX results show more oxidation occurs on the surface of the drilled holes.
- The foreign particles from electrode are penetrated at the surface.
- Surface indiscretions follow the likely normal pattern alike near that of erosion rates.
- Significant reserved metal which resoldified exhibits typical features of spark erosion in the form of gas pockets.
- The quenching effect of water as working fluid of Micro EDM Drill on Titanium

result irregular debris which sticks together.

- Lower erosion rate with decreasing current is in conformity to theory of electrical methods of machining.
- The Results of this study can be used for all the Micro Electric Discharge Machines that have similar control mechanisms. But workpiece and its thickness may vary the surface characteristics

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