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Study on Effect of Electro Chemical Micro Machining Process Parameters on Aluminium Matel Matrix Composite

Mr.R.K.Udhayakumar, M.E[1] , Akash R[2] , Gokul Raja R[3] , Gowtham R[4], Jayasurendhiran G[5]

Assistant Professor[1], Muthayammal engineering college, Rasipuram-637408, Student[2,3,4,5] , Muthayammal engineering college, Rasipuram-637408

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ABSTRACT:
The need for micro components/devices in the field of aerospace, automobile and medical is increasing day by day. There are various methods are available for manufacturing of such components/devices. Among the various non-traditional machining techniques, electrochemical micromachining (EMM) is found to be more suitable due to the reason for its higher material removal rate (MRR), good surface quality and accuracy.
In this research the micro-hole machining is performed on the Aluminium metal matrix composites work piece. Tool used in this project stainless steel needle. The Experiments are planned using electrolyte concentration machining voltage, duty cycle and Frequency. The optimal parametric combinations are obtained for machining the Aluminium. Additionally, Scanning electron microscope (SEM) images and Optical Microscope image have been used for the better understanding of micro- hole.

KEYWORDS: Electrochemical micro machining using aluminium metal matrix compostites.

I. INTRODUCTION

The process of creativity proceeds by way of research, design and development. The research work concerned with creation of new system. process, and equipment for the benefit of mankind is engineering. Research as the art of executing a partial application of scientific knowledge by utilizing the established facts, laws and principles of nature for the benefit of human rays. The new system emerging from innovation may be constituted by mechanical, electro mechanical. hydraulic, thermal, or other such elements. In these lines, this research tries to innovate the process of Electro Chemical Micro Machining (ECMM).
Electrochemical machining (ECMM) was developed during late 1950s and early 1960s and used to machine difficult-to-cut materials in aerospace and other heavy industries for shaping and finishing operations. It is an anodic dissolution process based on the phenomenon of electrolysis, whose laws were established by Michael Faraday. In ECM, electrolytes serve as conductor of electricity. ECM offers a number of advantages over other machining methods.

The ECMM technique now plays an important role in the manufacturing of a variety of parts ranging from machining of large metallic pieces of complicated shapes to opening of windows in silicon that are a few microns in size. When ECM is performed at micro meter level (material removal that’s range from 1-999 um).

In ECMM process, the work piece is connected to anode and the micro tool is connected to cathode and they are placed inside the electrolyte with a small gap between them.On the application of adequate electrical energy. positive metal ions leave from the work piece and machining takes place.Electrolyte circulation removes the machined particles from the electrode gap. To continue the machining electrode process, the gap has to be maintained by moving the tool at required rate.

ECMM is used for making smaller size components with high precision. Advanced micro machining process consists of various ultra-precision activities to be performed on very small and thin work pieces (Bhattacharyya B 2004). The high precision components with micro sized holes, slots, and complex surfaces are largely needed in mission critical applications like Nuclear power

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plant, Aero space industry. Electronics industry, and Bio-medical field.

ECMM is a very promising technology since it offers several advantages like a) higher machining rate, b) better precision and control, c) machining wide range of materials, d) cost effective, and e) environmentally friendly.The ECMM process is capable of machining electrically conductive. hard to cut materials without introducing any deformation on machined surface. In this process, no tool wear is produced Further, no residual stress is caused because machining is not done with direct force on the work piece. Instead. ionic dissolution is used to remove the material. Hence, there is no heat generation involved while machining. The ECMM process can be effectively used for high precision machining operations such as removal of micro burrs, making patterns in foils and 3D micromachining. These qualities and capabilities of ECMM.

II. ELECTRO CHEMICAL MICRO MACHINING

The ECMM system developed to conduct necessary experiments for this research work has the following five major assemblies. The schematic diagram of the ECMM setup

For the parts that come into contact with electrical system which requires insulation, fiber material is used. Parts that come into contact with electrolyte require noncorrosive materials and hence acrylic material is used in those places. The dimensions have been arrived based on the specifications found in published literatures. They were further modified considering the compactness, functional movements of mating parts, working conditions, arrangement constraints and space utilization. The machining setup structure consists of machining base over which rectangular column is mounted The column is. The lead screw is keyed with the stepper motor shaft and passes through the internally threaded hole of the electrode feeding section made of mild steel. The diameter and the length of the main screw rod are 12 mm and 183 mm respectively, In order to achieve very fine feed of the electrode thread has been made at 30 threads per inch for a length of 75 mm in the mid portion of the main screw rod. This enables the linear up and downward feed of electrode to a required level in accordance with the depth of the electrolyte chamber and work piece placement in it.When the stepper motor rotates, the lead screw rotates. which in turn moves the micro tool electrode holding device which provides electrode feed movements. Just below the tool electrode holding devices, the machiningchamber rests on a base plate. The base plate is provided with four bushes at the bottom for easy handling.The dimensions of other parts are calculated considering space arrangement and functional requirements. Inside the machining chamber, a work holding device is mounted. The work piece which is of few microns thick is held in the fixture, made up of two blocks of insulating material fastened with screws.Electrolyte we used Sodium nitrate is the chemical compound with the formula $NaNO_3$. This alkalimetal nitrate salt is also known as Chile saltpeter to distinguish it from ordinarysaltpeter,potassiumnitrate.Distilled water can be used in steam ironsfor pressing clothes to minimizes thebuild-upoflimescaleinhardwaterareasshorteningthelifespanofsteamirons.

Mounted with three angle plates with allen screws.

The size of the angle plate fabricated is 120 1008 mm.

It isSuitable to accommodate the stepper motor and other associated discrete parts. The other two angle plates support the lead screw with the help of bearings

III. TOOL AND WORKPIECE

TOOL

Most common tool materials are brass, copper and bronze, but stainless steel, titanium, sintered copper/tungsten, aluminium and graphite are also used.

In this Electro chemical micro machining process is using by the epoxy resin coated stainless steel short lengthened hollow wedge tool following below

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Stainless steel needle

WORK PIECE
The work piece will be taken the aluminium metal matrix of 0.2mm using the ECMM. The metal added in aluminum metal matrix composite is C K(8.51%), O K(13.87%), Na k(1.54%), Mg K(5%) Al K(30.36%), Si K(31.88%), S K(0.04%), Cr K(0.85%), Fe K(4.64%), Ni K(3.3%).

Aluminium metal matrix

IV. WORKING OF ECMM

ECM working is opposite to the electrochemical or galvanic coating or deposition process.During electrochemical machining process, the reactions take place at the electrodes i.e. at the anode (workpiece) and cathode (tool) and within the electrolyte.Let's take an example of machining low carbon steel which is mainly composed of ferrous alloys (Fe). We generally use neutral salt solution of sodium chloride (NaCl) as the electrolyte to machine ferrous alloys. The ionic dissociation of NaCl and water takes place in the electrolyte as shown below. First, the workpiece which is aluminium metal matrix composites assembled in the fixture and the tool which is stainless steel neeedle brought close to the workpiece. The tool and workpiece is immersed in a suitable electrolyte.After that, a potential difference is applied across the w/p (anode) and tool (cathode). The removal of material starts. The material is removed in the same manner as we have discussed above in the working principle.Tool feed system advances the tool towards the w/p and always keeps a required gap in between them. The material from the w/p comes out as positive ions and combine with the ions present in the electrolyte and precipitates as sludge. Hydrogen gas is liberated at the cathode during the machining process.Since the dissociation of the material from the w/p takes place at atomic level, so it gives excellent surface finish.The sludge from the tank is taken out and separated from the electrolyte. The electrolyte after filtration again transported to the tank for the ECM process.

V. EXPERIMENTAL DC READING

Test	MV (v)	DutyCycle %	EC (g/l)	M/ctimefor SStool um/sec	OMI(um)for AMM
1	9	95	26	39.7	-
2	10	95	26	37.42	-
3	11	95	26	36.20	-
4	12	95	26	33.20	164
5	13	95	26	29.29	174

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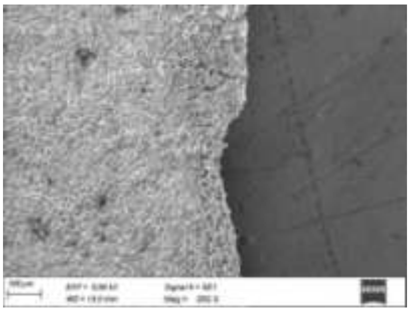
VI. SCANNING ELECTRON MICROSCOPE(SEM)

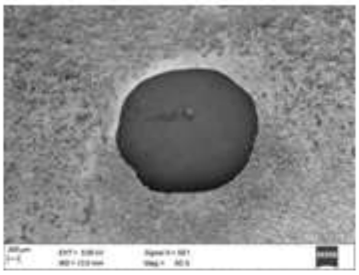
A Scanning electron microscopic(SEM) is a type of electron microscopic hat produces the images of a sample by scanning the surface with focused beam of Elctrons interact with atoms in the sample producing the contain.SEM image can achieve resolution better than 1 nanometer specimens can be observed in high vacuum in conventional SEM with specialized instrument.The most common SEM node is detection of secondary electron emitted by atoms exited by the electron beam the no.of secondary electrons can be detected depends on specimen, topography. An image displaying the topography surface.

SEM IMAGE OF EXPERIMENTS @100UM



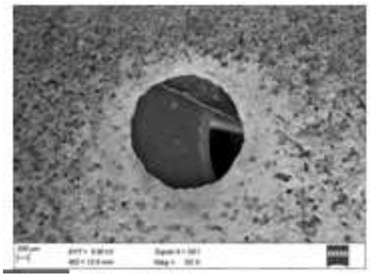
HOLE 1

SEM IMAGE OF EXPERIMENTS @200UM



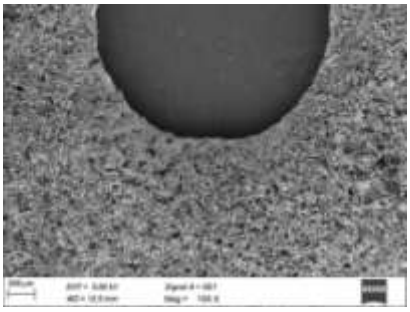
HOLE 2

SEM IMAGE OF EXPERIMENTS @200UM



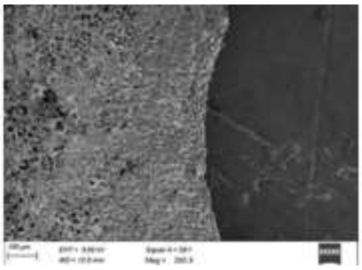
HOLE 3

SEM IMAGE OF EXPERIMENTS @200UM



HOLE 4

SEM IMAGE OF EXPERIMENTS @100UM



HOLE 5

VII.OPTICAL MICROSCOPE TEST

The object is placed on a stage and many be directly viewed through one or two Eye pieces on microscope. In high power microscope, both eyepiece typically show the same image, but with stereo microscope, slight different images are used to create effect. A camera is typically used to capture the image.The sample can be lit in the variety of ways. Transparent object can be lit from below and solid objects can be lit with light coming through or around the object lens. Polarized light may be used to determine crystal orientation of metallic object. Phase contrast imaging can be used

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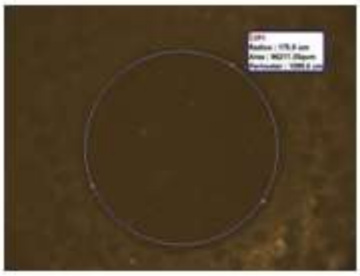
to increase image contrast by highlighting small details of differing refractive index. A range of objective lenses with different magnification are usually provided mounted on a turret, allowing them to be rotated into place and providing a ability to zoom-in. the maximum magnification power of optical microscope is typically limited to around 1000x because of the limited resolving power of visible light. While larger magnification are possible to additional details of the object are resolved.Alternatives to optical microscopy which do not use visible light include SEM and transmission electron microscopy and scanning probe microscopy and as a result, can achieve much greater magnifications.

HOLE 4



HOLE 5

VIII. CONCLUSION

The influence of machining voltage, pulse on time and electrolyte on the machining rate and overcut for the different electrolyte type like sodium nitrate and distilled water have been investigated experimentally. Based on the studies conducted, the following conclusion are made

1. The machining rate and overcut significantly influenced by electro lyte

2.Based on the conducted studies, when accurate holes need to be produced on 304 stainless needles, Acidified sodium nitrate electrolyte is recommended because of their higher machining rate and lesser overcut

SEM analysis and optical microscope imaging is taken for the understanding of roughness of hole. The present research consists of a detailed experimental investigation based on the analysis of the obtained test results to study the influence of the various process parameters.

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