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A Study on Sequential µ-EDM and its Advantages

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Abstract**:** ***The use of sequential traditional and non-traditional µmachining methods associated with µ-EDM have been thoroughly addressed in this paper, along with their applicability in current research and industrial domains. The requirement as well as Sequential µmachining technologies provide several advantages over hybrid µmachining processes. µmachining has been thoroughly investigated. The advantages of µ-EDM in combination with processes like grinding, milling, µ-turning, µ-ECM and laser µmachining have been discussed. Demands are too great for a single machining technique to satisfy, necessitating the use of a sequential micro machining process. The common obstacles that obstruct the successful execution of sequential operations or compromise their accuracy have also been addressed along with some potential solutions to the problems.***

Keywords: micromachining, EDM, sequential machining

I. INTRODUCTION

A significant range of fabrication processes for machining µ-components have been developed and are used on a regular basis. µ-grinding, µ-turning, µ-milling, µ-drilling, and other techniques include µ-electric discharge machining (µ-EDM), µ-electrochemical machining (µ-ECM), laser µmachining (laser µmachining), and so on. Some of these machining methods are old-fashioned, while others aren't. Each has its own set of advantages and disadvantages, and none of them is suitable for all materials or design methods. Processes are carried out in a sequential or one-by-one order. Even if the machining procedures are carried out on the same experimental setup, they are not necessarily hybrid as long as they are not carried out at the same time.

As previously said, sequential µmachining has numerous advantages, but executing such a combination µmachining process is a difficult undertaking. For this type of sequential system, machine tools have specific requirements. Accurate machine tool measurement is also required, which is frequently lacking. Furthermore, typical CNC machines frequently fail to attain the precision required in this type of combined machining operation. In traditional machining procedures, thermal deformation, mechanical failure, tool wear, clatter, and vibration are all common issues that prevent the manufacture of super accurate,-components and machine parts. As a result, the first step in creating a sequential system is to design versatile machine tools and settings from the outset, so that some specific applications can be merged.

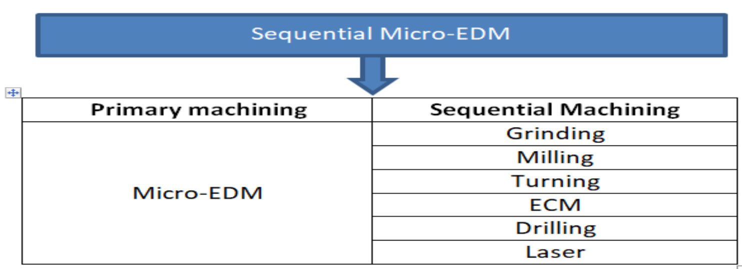

Fig.1: Primary and sequential machining in µ-EDM

II. ADVANTAGES OF SEQUENTIAL µ-EDM

A. There are a variety of methods that aren't ideal for machining specific materials which can be milled with µ-EDM, but they're better at finishing. When those techniques are combined, they can produce greater results than either µ-EDM or that process alone.
B. Tool wear is a major worry when employing µ-EDM, but sequential machining can minimise it.
C. In a lot of circumstances, combining µ-EDM with another µmachining method is a good idea. The entire process is speed up, resulting in increased productivity.
D. µ-EDM is frequently used to create machine components for various machining techniques, such as electroplating, milling, drilling and grinding electrodes or other machine parts

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III.µ-EDM & ECM

µ-Electro discharge machining as previously said is a popular method of machining miniature components and 3D µstructures since it is a non-contact, low-cutting-force procedure. It can manufacture a wide range of materials and can also create complicated 3D things. Surface quality, electrode wear, and tool servo stability are all determined by the geometry of electric discharge erosion pits. µ-ECM, on the other hand, avoids the problems of electrode wear and multiple electrode preparation. This approach also improves surface roughness by avoiding generating a heat damaged layer or µ-crack on the machine surface. The study has proceeded by merging these two approaches, where µ-EDM was used for shaping and µ-ECM was used for finishing.

µ-EDM has also been utilised in conjunction with the electrochemical etching technique. An array of µelectrodes was created using a combination of µ-EDM with electrochemical controlled etching. Rectangular columns of 0.2 mm*0.2 mm were manufactured using wire EDM, and then electrochemical etching was utilised to transform them into cylindrical columns. This sequential approach can process a wide dimensional range of µ-metres [1].

The system performs best when the machine voltage is 10 V, the starting machining spacing is 10 m, and the tool feed rate is 10 mm/s. The µ-EDM-machined surface roughness was reduced from 0.707 to 0.143 m Ra after ECM finishing. It was also able to totally eliminate burrs, µpores, recast layer, and craters from the surface. The faster the electrode feed rate, the smoother the surface and the better the shape of the workpiece. Overall, this combined approach has proven to be quite effective in machining complicated 3D metallic µstructures [2].

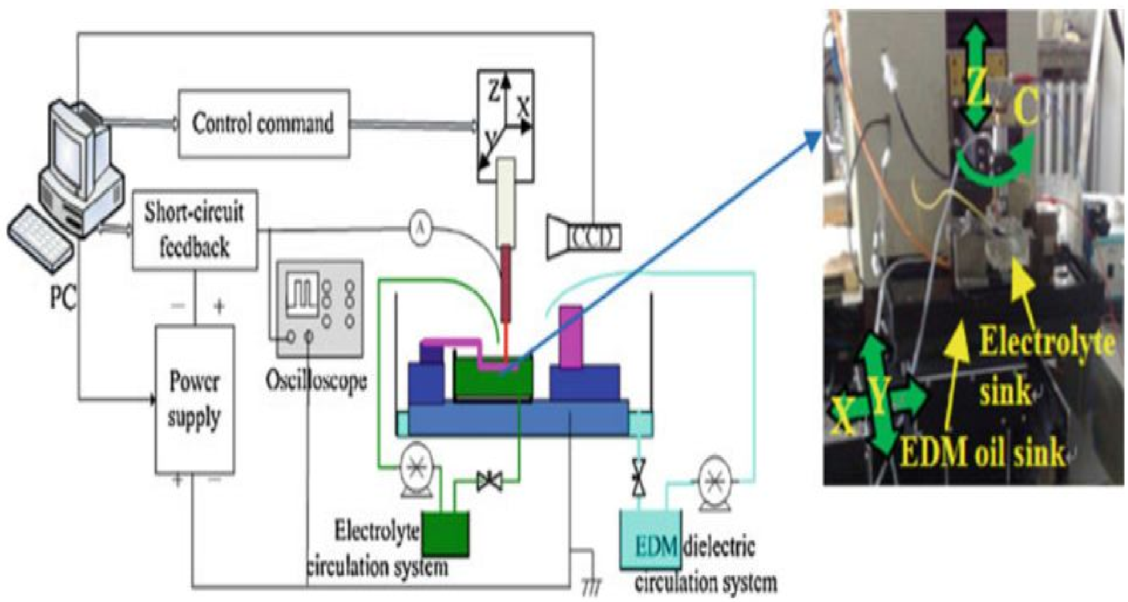

Fig. 2: Sequential set up of µ-EDM & ECM [2]

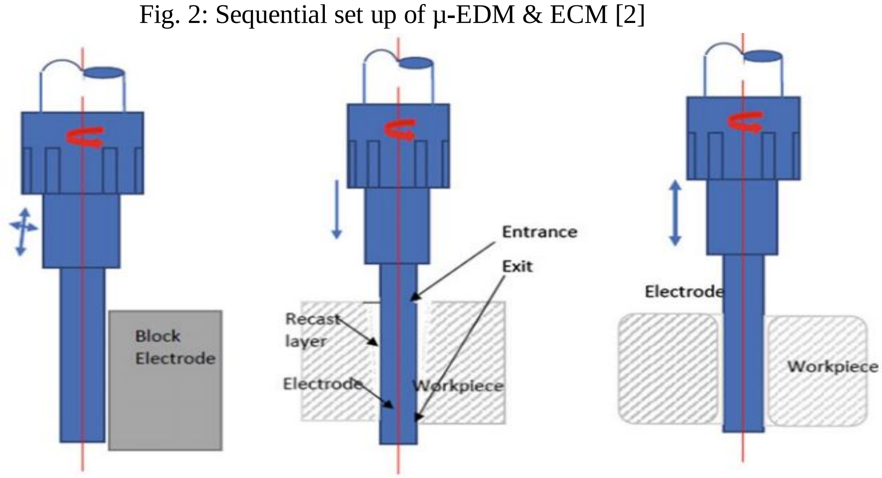

Fig.3: Electrode fabrication, shaping and finishing [3]

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IV. µ-EDM & MILLING

In today's manufacturing industry, fabricating complicated three-dimensional µstructures has become a pressing need. Grinding is usually preferred when working with hard moulds, and µ-diamond wheels are used. The freshly developed glass goods, on the other hand, are delicate to be machined using grinding wheels. They're also asymmetric along the axis. µ-milling technology, which is one of the most essential elements in mechanical µmachining procedures, may be used to produce these complicated 3D shapes.

It is necessary to achieve µmachining in the ductile phase when µmachining hard and brittle materials, and the geometrical configuration and accuracy of µ-end mills facilitate this [11]. Mechanical µ-milling has the advantage of not requiring any post-processing. A six-axis WEDM was used to create the PCD ball end mill having four flutes of 0.3mm. The ductile mould machining is confirmed by the negative rake angle [12].

V. µ-EDM & GRINDING

Due to its inexpensive setup cost, improved precision and accuracy, and broad design freedom, µ-EDM has become increasingly popular in the manufacturing and research areas[4]. As this is a no-contact between the tool and workpiece so cutting force, mechanical stress, friction, and vibration issues are not a major concern. There has been a lot of research into sequential and hybrid µ-EDM machining. µ-ECM, laser µmachining, electropolishing, µ-milling, µ-grinding, and a variety of other techniques have all been incorporated [5]. µ-EDM, despite its many benefits, has certain drawbacks, the majority of these sequential and hybrid machining technologies are used. Because of the recast layer created on the machine surface, it produces poor surface quality. Discharged craters and µ-cracks are commonly found in the µ-EDM-machined region [6]. In another study the researchers used a sequential combination of µ-EDM and grinding to true a piece of polycrystalline diamond (PCD) tool by µ-EDM before being used in grinding. This integrated approach can manufacture precise µstructures in the shapes like V-grooves [7].

VI. µ-EDM & LASER MACHINING

Combining two of the most prominent µmachining processes, µ-EDM and laser µmachining, is gaining traction, and it has a wide range of applications, particularly in fuel injection nozzles and µ-part assembly. These two procedures are frequently employed following mechanical µ-drilling, resulting in a three-step µmachining process. It is a requirement in diesel fuel injection nozzles to have hole sizes less than 145 m in order to reduce harmful emissions to the environment and achieve improved energy efficiency. µ-EDM drilling is a familiar technologies for this purpose, but it has drawbacks, such as greater tooling costs due to frequent electrode breakage [7]. This procedure also has a lower rate of material removal [8]. Researchers have tried employing a nanosecond pulse laser beam for this, however it is unable to produce industrial-standard hole quality due to bigger recast and heat-affected zones [9].

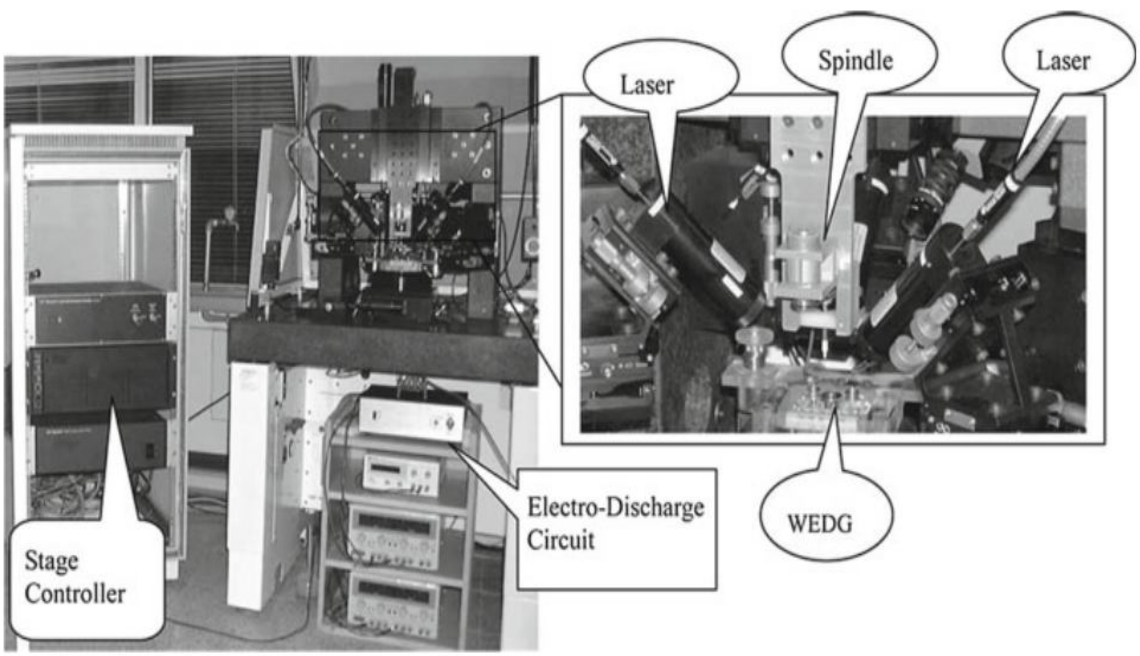

Fig.4: Sequential setup of µ-EDM and Laser machining [10]

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VII. CONCLUSION

At present a considerable number of super alloys, composites and ceramics are employed industrial and research sector of manufacturing, that are very much difficult to mill using frequently available traditional machining procedures. Even non traditional machining technologies, i.e., EDM, LBM, ECM finds limitations in catering production necessities. Machining with high precision accuracy and a superb surface polish of 3D complex intricate designs These new demands are too great for a single machining technique to satisfy, necessitating the use of a sequential µmachining process. When used in conjunction with other µmachining procedures, µ-EDM can address a lot of problems that were previously intractable.

REFERENCES

[1] Wang MH, Zhu D, Fabrication of multiple electrodes and their application for micro holes array in ECM. *Int J Adv Manuf Technol* 41(1–2):42–47, 2009

[2] Zeng Z, Wang Y, Wang Z, Shan D, He X, A study of micro-EDM & micro-ECM combined milling for 3D metallic micro-structures. *Precision Eng* ineering 36(3):500–509,2012

[3] He XL, Wang YK, Wang ZL, Zeng ZQ , micro-hole drilled by EDM-ECM combined processing. *Key Eng Mater* 562–565:52–56,2013

[4] Lim HS, Wong YS, Rahman M, Edwin Lee MK, A study on the machining of high-aspect ratio micro-structures using micro-EDM. *J Mater Process Technol* 140(1–3):318–325,2003

[5] Ho KH, Newman ST, State of the art electrical discharge machining (EDM). *Int J Mach Tools Manuf* 43(13):1287–1300,2003

[6] Liu HS, Yan BH, Chen CL, Huang FY, Application of micro-EDM combined with high-frequency dither grinding to micro-hole machining. *Int J Mach Tools Manuf* 46(1):80–87,2006

[7] Pham DT, Dimov SS, Bigot S, Ivanov A, Popov K, micro-EDM—recent developments and research issues. *J Mater Process Technol* 149(1–3):50–57,2004

[8] Weng FT, Her MG, Study of the batch production of micro parts using the EDM process. *Int J Adv Manuf Technol* 19(4):266–270,2002

[9] Dausinger F, Precise drilling with short-pulsed lasers. High-power lasers in manufacturing. *SPIE proceedings*, vol 3888, pp 180–188,2000

[10] Kuo CL, Huang JD, Liang HY, Fabrication of 3D metal microstructures using a hybrid process of micro-EDM and laser assembly. *Int J Adv Manuf Technol* 21(10–11):796–800,2003

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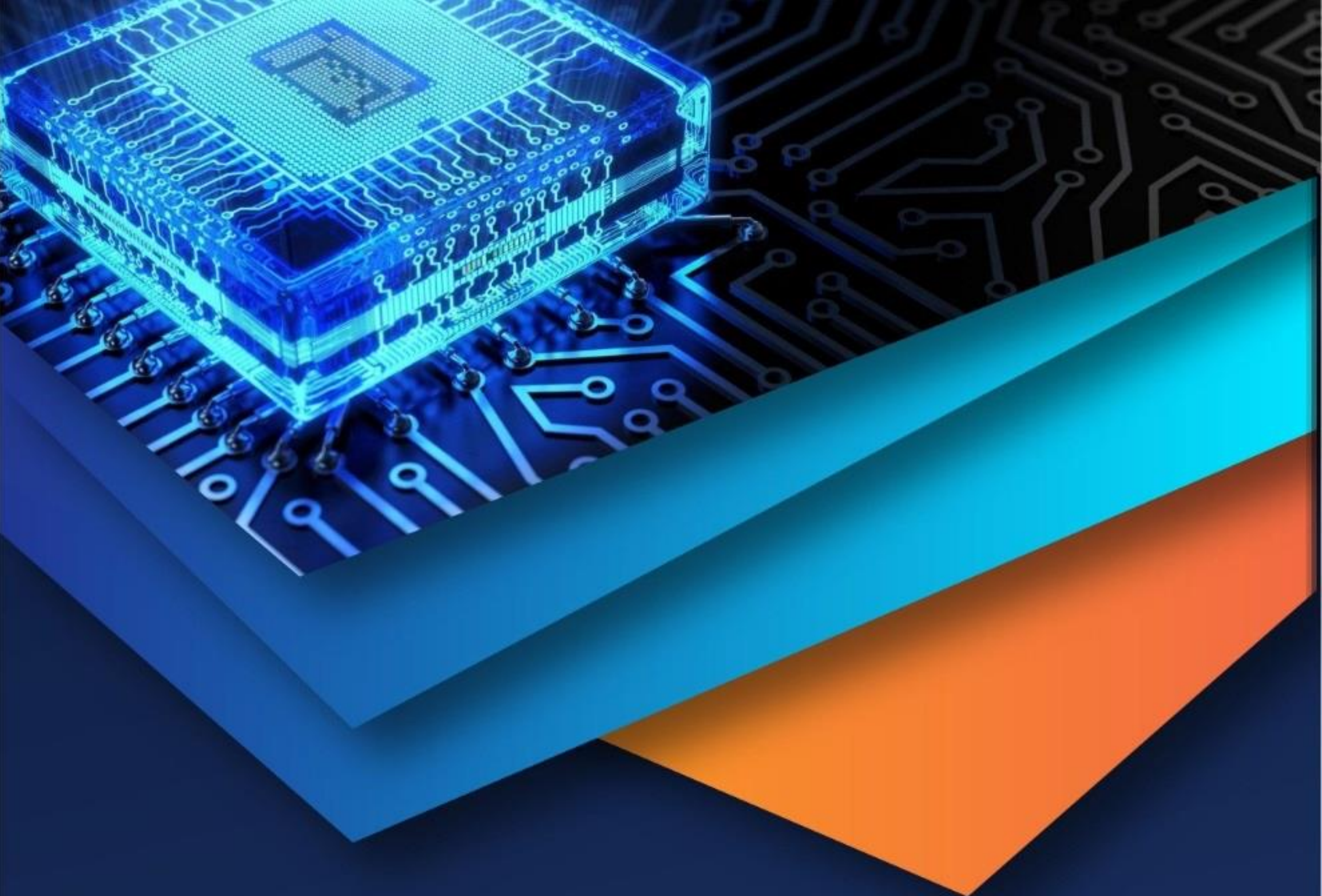

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