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Comparative Analysis of Various Aa7075 Composite Meatl Matrix Machining Parameters and Geometrical Characteristics by using EDM Process

V Sarayu, S Vijay Baskar, C Vijay Dharsan, M Thirunavukkrasu

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CHAPTER -1

ELECTRICAL DISCHARGE MACHINING

1.1 INTRODUCTION

In the mechanical field, the trend of using lightweight, slim, and compact mechanical components in the medical, nuclear reactor, aerospace, and automotive industries leads to the growth of strong materials with high-temperature resistance properties and strength for various applications. These materials have various features, like being highly corrosion resistant, less heat sensitive, tougher, and harder, but it is also difficult to machine . The conventional methods are inefficient in machining these "difficult-to-machine" materials with higher accuracy. Additionally, materials with high surface finishes, tight tolerances, and complicated geometries make conventional methods difficult. It sparks the evolution of advanced and new technologies which compute with ease and precision. Electrical discharge machining (EDM) is widely applied to machines like high-strength and temperature-resistant (HSTR) alloys and 'difficult-to-machine.' It is mainly utilized in the mold and die-making industries. Joseph Priestly, a physicist, discovered the corrosive impact of electrical discharges on metals in 1770. Dr. Russian scientist B.R. Lazarenko and Dr. N.I. Lazarenko developed the later EDM method in 1943. Intermittent arcing in the air between electrodes attached to a DC power source was used to detect material erosion.

Electrical discharge machining (EDM) is a non-traditional thermoelectric machining method of removing materials by generating a sequence of electric sparks when electrodes are held closely together in a dielectric medium. A large potential difference is applied across them. These sparks cause localized zones of high temperature, which causes the material in the workpiece to melt and vaporize. The inter-electrode gap of the first spark is minimum.

The machine regions are overheating, resulting in minimum accuracy. Early power supplies of the resistance-capacitance (R-C) variety, commonly referred to as the Lazarenko, employed a circuit that served as a spark producer for EDM machines. The development of orbiting systems and the implementation of pulse and solid-state generators during the 1960s helped ease the problems associated with weak electrodes. Due to the advancement, the number of electrodes utilized to create cavities decreased in the 1970s. The first generation of computer numerical controlled (CNC) EDM was released in the United States of America in the 1980s, which greatly increased the productivity of EDM. CNC control system enables smoother finishing cut through the Self-regulated and un attended machining.

Figure.1.1 (a) The ignition phase **Figure.1.1 (b)** Plasma channel formation

Figure.1.1 (c) Melting and evaporation **Figure.1.1 (d)** Ejection of liquid molten material

Figure:1.1 Various stages of EDM

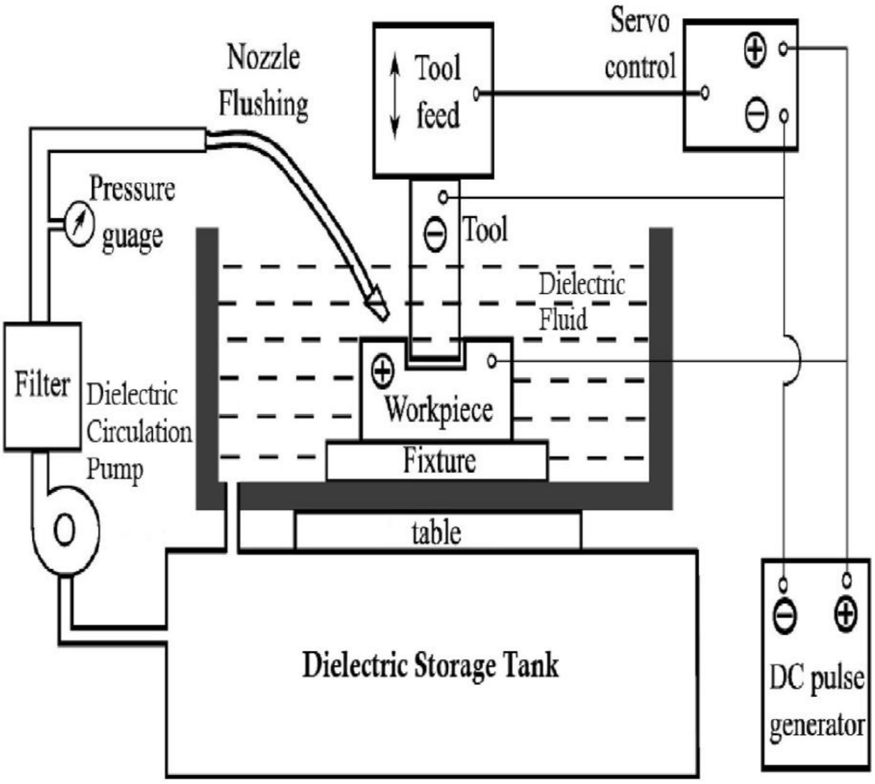


Figure:1.2. EDM setup.

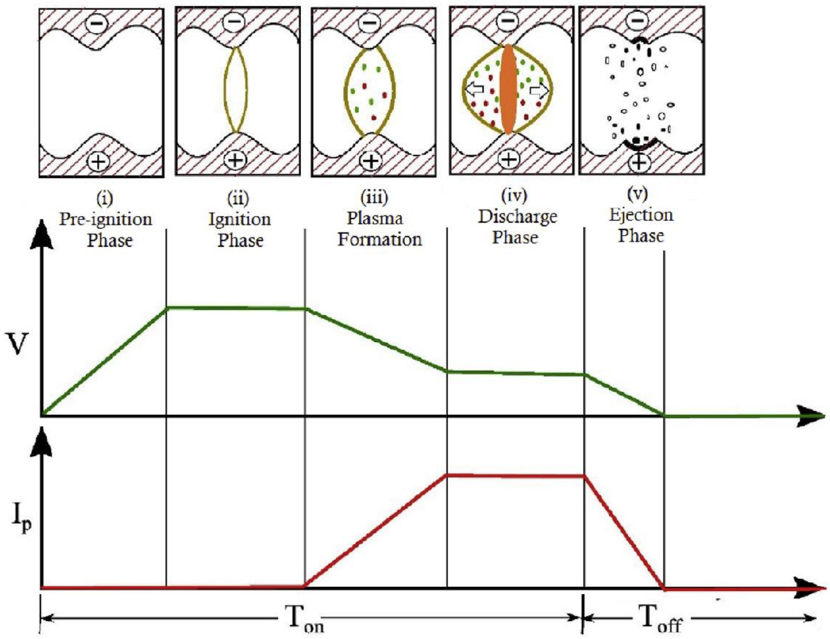


Figure:1.3. Mechanism of Material removal in EDM.

Material removal maximizes the Inter electrode gap, leading to the subsequent spark from one point to another. Similar to the electrode gap, a succession of sparks appears at various places on the workpiece. Irrespective of hardness, shape, or strength, any electrically conductive material can be machined using this method [8, 9]. Despite these drawbacks, EDM is frequently used to create complex shapes [10, 11] quickly. These drawbacks include the process's poor surface smoothness, high tool wear ratio (TWR), and low material removal rate (MRR). Therefore, the manufacturing industries are eagerly seeking technological advancements to enhance EDM's surface finish and machining effectiveness.

1.2 EDM PROCESS

EDM's material removal process is still under debate whether it is recognized. But it is the widely accepted and acknowledged material erosion system. EDM works based on the thermo-electric model in which electrical energy is transmitted to thermal energy through various discrete electrical discharges among the two electrodes. The two electrodes represent the tool and workpiece submerged in dielectric fluid. The potential difference causes the cathode to emit electrons, and the emitted electrons from the cathode released electrons race to the anode.

Further strikes the dielectric fluid, splitting into electrons and positive ions. Sparks are produced when a narrow column of dielectric fluid molecules that have been ionized forms among the electrodes. On the workpiece surfaces, a crater is generated as a result of the electrode. The workpiece melts and evaporates due to the formed plasma channel, which elevates the temperature from 8000 C to 20000 C. When the pulse is stopped, the plasma channel collapses, and the inter-electrode gap fills with minute particles of machined material flushed out by the circulating dielectric fluid. The surface of the workpiece is similarly generated using a succession of crates, creating a rough machined surface. A standard EDM setup is demonstrated in Figure 1.The technical inventions in automotive, nuclear, aerospace and other industries maximize the complexities of hard materials and machines. Hard materials such as ceramic materials, thermal characteristics, the latest metallic materials, and composites possessing efficient thermal and mechanical characteristics with proper electrical conductivity are suitably machined through the spark erosion mechanism. In addition to poor material removal rates, the complication in size, shape, and the high demand for surface quality and product accuracy can be overcome using unconventional procedures.

Electrical Discharge Machining (EDM) is a non-conventional technique widely implemented for manufacturing dies, tools, and other parts with maximum accuracy. EDM replaces conventional machining processes like grinding, drilling, and milling. It has become a widely accepted preferred machining technique for industries machining geometrically composite material components like ceramics, carbides, heat-resistant steels, super alloys, composites, heat-treated tool steels, etc. EDM has recently had its footprints in sports, medical equipment, surgical instruments, and optics sectors. It is a well-defined approach to address the rising need for complex, small-sized, and multifunctional parts utilized in the microelectronics industries. Manufacturing carburetors, cylinder liners, piston heads, and engine blocks are a few specialized applications of EDM. Additionally, it is commonly used in dental equipment, medical implants, and surgical equipment.

Russian scientists Boris and Natalya Lazarenko first developed EDM in 1943 in Moscow while examining wear produced by the existence of sparks among tungsten electrical connections. Controlled sparking is a method applied to degrade the material. It was discovered that sparks were steady when the electrodes were submerged in oil instead of in the air. The earliest EDM machines were developed in the 1950s. The expansion of the semiconductor sectors in the 1960s encouraged significant advancement in EDM equipment. Micro-machining with EDM became very popular in the 1980s. In the 1990s, the development of new EDM techniques using central composite design, Taguchi optimization, neural networks, and fuzzy control, among other methods. Research works are still in progress for developing a cutting-edge concept for carbon nanotubes, nanoparticles, conductive powders, and other additives to be added to the dielectric fluid are being explored.

1.3 Principle of Electrical Discharge Machining

EDM approaches are thermo-electric, which eliminates the material from the workpiece through a sequence of discrete sparks between the tool and the workpiece contained in a dielectric medium. When the electrode travels towards the workpiece, the ionization of the dielectric generates brief discharges in the inter-electrode gap. The eroded particles are flushed continuously through the aperture. Because there is no direct contact between the tool and the workpiece during machining, there are no mechanical strains, chatter, or vibration issues.

The tool electrode technique in the workpiece maximizes the electric field and reaches the fluid-ionization point. It happens when a spark can begin depending on the distance between the tool and the workpiece and the dielectric's strength. The voltage falls between 25 and 45 volts at the discharge time. When a spark discharge occurs, the voltage remains constant, but the current amplitude quickly increases to a predetermined fixed value. The electrons move from the negative-polarity electrode to the positive-polarity workpiece. The work piece's positively charged electrons travel in the direction of the tool electrode's negatively charged electrode. Positive ions and traveling electrons generate plasma channels.

1.3.1Steps in EDM

Figure 1.1 illustrates the five sequential stages that lead to an electrical discharge between the tool and the workpiece. The five stages are described below;

1.3.2 The ignition stage (Figure.1.1 (a))

The cathode releases the primary electrons from the locations with the greatest gradient when a voltage gradient characterizes an electric field. These electrons are drawn to the anode and begin traveling in its direction, colliding with the metal atoms in the dielectric. The atoms subsequently split into positive ions and secondary electrons.

1.3.3 Creation of the plasma channel (Figure.1.1 (b))

More electrons are released whenever the positive ions strike the cathode, and this method is named secondary emission. Numerous neutral dielectric atoms are split apart by these electrons as they proceed in the direction of the anode. The created current by the electrons and the ions increases when the dielectric begins to heat up locally. As a result, the electrical resistance is reduced, and the current is maximized. A plasma channel with high pressure and temperature is generated as the dielectric keeps heating up. The plasma channel creation process is also known as the voltage breakdown phase. The ignition delay time is the amount of time that passes between the application of voltage and voltage breakdown.

1.3.3 Melting and evaporation (Figure.1.1(c))

The kinetic energy is converted into heat during the ion or electrons colliding with the surface. The surface melting and partial evaporation is caused by this heat. The total ions or electrons that impact the surface determine how much material is molten. The discharge current and discharge time both affect how many colliding particles are produced at each discharge. Because of the disparity in mass, only a small number of ions collide with the cathode when short discharge periods are used, which results in considerable heat generation from the electrons. The cathode surface melts due to the intense heat of the ions' high kinetic energy.

1.3.4 Ejection of the liquid molten material (Figure.1.1 (d))

The EDM machine suddenly stops the current after the user's discharge time. The subsequent plasma channel collapses create pressure, resulting in sudden molten cathode and anode surface drops. This causes little molten metal droplets to eject from the pool of molten metal and causes the molten materials at the electrode and workpiece to boil fiercely.

1.3.5 Solidification and flushing of eroded particles (Figure.1.1 (e))

The voltage and discharge current is shut down during the pulse-off period, and the pool of molten metal is flushed away, leaving a tiny crater in the workpiece.

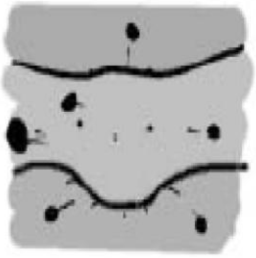


Figure.1.1 (e) Solidifying and flushing of the eroded particles

Figure 1.1 Steps in EDM

Figure: 1.4 Steps in EDM

1.4 Classification of EDM

The various classification EDM illustrates here

Die-sinking EDM

An insulating dielectric fluid is used to surround the tool and workpiece. The tool reaches the workpiece surface and sparks because the power supply creates a voltage potential. The tool creates its profile in the workpiece, and when the material is removed, it preserves the gap by automatically moving forward.

Wire-cut EDM

The workpiece is shaped with a metallic wire of 0.1 mm diameter steel, brass, or copper, including the planned path at the time of constant circulatory motion. As a dielectric, deionized water is immediately inserted around the wire

Electro-discharge Milling

A spinning cylindrical electrode travels along a predetermined path to create the appropriate form on the workpiece surface. Simple-shaped electrodes eliminate material from the workpiece in layers to create a complicated three-dimensional shape. The control system establishes the electrode feed rate.

Electro-discharge grinding:

The grinding wheel's rotating action shapes the workpiece through electrical discharges and then facilitates the ejection of molten material.

Micro-EDM

Micro-EDM plays a significant role in manufacturing tool inserts for surgical equipment, intricate three-dimensional shapes, shafts, micro-injection molding, and metal sheets with micro-holes of diameter less than 5μm.

1.5 EDM PROCESS VARIABLES:

The following are the most significant process variables that affect the EDM process:

(a) **Peak discharge current**: At the time of sparking, peak current, which reflects the total power needed for machining, increases to a specific predetermined level. During discharge, the power is directly proportional to the highest discharge current. Surface roughness, tool wear rate, and material removal rate all rise as peak current increases.

(b) **Discharge voltage**: The open-circuit voltage is also defined as the voltage of applied pulses. Electrical discharges cause a different voltage across the gap than normal. The surface roughness and TWR rise due to an increase in open circuit voltage, which also increases the field strength. The discharge voltage is linked to the spark gap and the dielectric's breakdown strength. For the current flow, the working gap is stabilized due to the voltage drop caused by the discharge voltage's creation of the ionization channel. Increased discharge voltage will increase the working gap, enhancing flushing circumstances.

(c) **On-time (pulse on time or Ton):** It is the amount of time that the current flows in a single cycle. The energy used during this time is directly proportional to the amount of material removed—the on-time duration and peak current control this energy. The bombardment of electrons caused by shorter pulse on times causes the material removal rate to rise. Still, the energy sharing by ions caused by longer periods causes the material removal rate to fall.

(d) **Off-time (pause time or Toff):** The dielectric is re-ionized by the time gap between successive sparks. During this time, the molten material solidifies and is flushed away. This parameter determines how quickly and steadily the crater forms. The longer the machining time, the greater the Toff. Smaller off-times will result in faster machining and unstable sparks. The spark frequency influences the machined specimen's surface roughness. As more sparks use the energy available in a given period to generate shallow craters with fewer roughness values, high-frequency sparks yield less surface roughness [13].

(e)**Arc gap (or gap):** The arc gap is called spark gap, defined as the distance between the electrode and workpiece during machining. Ensuring proper gap achieves performance efficiency and adequate stability. The servo head regulates the gap voltage as the dielectric properties change constantly. The average gap voltage can be used to calculate the gap width.

(f) Pulse Interval, duty factor, or pulse frequency: Pulse interval, duty factor, or pulse frequency defines the separation of pulses. The ratio of pulse-on-time to total cycle time is known as the duty factor. By providing the duty factor and pulse duration, machines with duty factor settings indirectly require the pulse interval. The pulse interval can also be adjusted on some machines using the pulse frequency.

(g) Polarity: It defines the polarity of the electrodes on the workpiece and tool. The electrical state reveals the direction in which the current stream is flowing concerning the electrode. In contrast, to reverse polarity, which involves a positive tool and a negative workpiece, straight polarity involves a negative tool and a positive workpiece. Modification of the polarity is based on the application.

(h) Dielectric fluid: The eroded particles are flushed away by the dielectric fluid because they will cause a short circuit if not removed. The electrode gap is cleared for the upcoming discharge during the post-discharge. If particles are not removed completely, the dielectric's electrical conductivity rises, making it harder to manage the operation and leading to poor machining quality. The dielectric typically flows across the gap to enhance flushing.

CHAPTER-2

LITERATURE REVIEW

2.1 INTRODUCTION:

Electro Discharge Machining is a non-conventional or non-traditional machining process which is used for machining hard materials which are difficult to machine by the conventional machining process. EDM can be used in machining difficult cavities and contours. There are various types of products which can be produced using EDM with high precision and good surface quality, such as dies and molds, parts for aerospace and automotive industry and surgical components. A composite material comprises two or more chemically and/or physically apparent phases. Composite materials, also termed as composition materials or known as composites, are naturally or engineered appearing materials produced from two or more composing materials with considerably different chemical or physical properties which persist distinct and separate within the finished structure. The constituent elements, mainly comprises a reinforcing element, fillers, and a composite matrix binder which differ in composition or form on a macro-scale. The constituent elements preserve their own characters means they do not merge or dissolve completely into one another although they act in concert. Normally, the constituents exhibit an interface between one another and can be physically identified. Composites which are of heterogeneous structures accommodate the necessities of specific function and design, infused with ambitious properties which limit the scope for classification. However, this blunder is made up for by the reality that new varieties of composites are being invented, each with their own specific characteristics and purpose like the particulate, flake, laminar and filled composites. Particles or fibers entrenched in matrices of another material are the most suitable example of modern-day composite materials, which are mostly structural. The present study deals with machining and machinability aspects of Metal Matrix Composites (MMCs) (Hybrid Composites) emphasizing parametric appraisal and multi-objective optimization in relation to machining performance features.

Muhammad Umar Farooq et al. [1] (2023) developed experiments in EDM to reveal the optimal process parameter for titanium alloys using surfactant-assorted dielectric fluid. They mentioned that surfactant-mixed dielectric fluid possesses an excellent chemical nature to increase conductivity in machining due to its biodegradable and non-harmful characteristics. The machining performances are improved by about 41.7% with the surfactant-suspended dielectric fluid compared to the normal dielectrics. They mentioned that surfactant-suspended dielectric induces bioceramic oxides, which induce the formation of the oxide layer on the workpiece and cause corrosion resistance.

V.P. Srinivasan et al. [2] (2018) were studied Si3N4-TiN composites are fabricated by hot pressing and spark plasma sintering (SPS) process. Selection of appropriate machining parameters in EDM is one of the most important aspects taken into consideration as these conditions determine the important characteristics such as material removal rate (MRR) and electrode wear rate (EWR) among others. The main machining parameters such as gap voltage (V), current (I) and pulse-on time (Ton) were chosen to determine listed technological characteristics. The characteristic features of the EDM process are explored through response surface methodology (RSM) based on design of experiments (DOE). Moreover, an L18 orthogonal array based on DOE to conduct a series of experiments has been adopted. From the results, it is evident that the current is the most significant factor as it influences both MRR and EWR. The high current increases the MRR and the less gap voltage reduces the EWR.

Prabu Rajendran et al.[3] (2023) conducted the experiments with the EDM process to reveal the optimal parameter combination along with the graphite powder mixed dielectric solution on aluminum 7075 alloy and titanium reinforced composite material. They used the copper material as a tool electrode with a size of 10 micrometers in diameter. The effect of graphite powder mixing with dielectric causes better conductivity in dielectric, which emphasizes the 40% improved MRR and 36% better surface finish than the normal dielectric.

Farooq et al. [4] (2023) studied the EDM performance of titanium alloys using different tools and dielectrics, such as cryogenically treated aluminum and graphite electrodes. The results of the experiments are compared with the outcomes of MRR, microhardness, and SR values. Dielectrics, such as kerosene and powder-mixed kerosene, are used for the experiments along with the different tool electrodes. Based on the results, higher SR values of 7.5 µm and 5.8 µm are noted for aluminum and graphite electrodes, respectively. Also, 25 g/l of mixed powder explored the lesser SR of 3.4 µm for the cryogenic graphite tool electrode

Vidyapati Kumar et. al. [5] (2023) included peak current (I), pulse-on time (Ton), and inter-electrode gap (IEG). The results of our study showed that the CoCoSo approach is an effective method for tool selection in EDM, and it can be used to identify the optimal tool material and machining conditions for creating circular holes on SG iron. The final appraisal scores obtained from the ranking of tool materials indicated that copper tools scored highest (2.4767, ranking 1), followed by copper tungsten (2.3615, ranking 2), while brass scored lowest (1.6606, ranking 3). Furthermore, Spearman's rank correlations for different integrated MCDM techniques were performed, which demonstrated the efficacy of this technique. It has been demonstrated that implementing the SWARA-CoCoSo method can effectively optimize the EDM process with regard to sustainable machining practices.

Equbal et al. [6] (2023) investigate the EDM process using high strength structural steel, such as ABS P 400 tool electrodes, on mild steel. They employed parameters such as PC, machining voltage, and pulse time for the experiment at the three levels. Optimization techniques such as response surface methodology are used to reveal the best machining parameter combination. The ABS tool electrode produced two times better MRR and 23.5% less SR than the normal tool electrodes. Also, the tool wear rate of the ABS tool is significantly lower than that of normal tools due to its high creep strength.

Kumar et al. [7] (2023) studied the tool geometrics for better machining performance in the EDM process using different tools and sizes in SS 304 work material. They consider the input parameters, such as machining current, PTand off time, and machining voltage, at different ranges. The output characteristics, such as MRR, surface roughness, and TWR, are measured to reveal the machining output. Based on the results, a 13% higher MRR was obtained with a higher diameter of the tool electrode. Also, lesser important influences are on the TWR and surface toughness.

Chinmaya P. Mohanty et al. [8] (2023) were used in the analysis of material removal rate, electrode wear ratio, surface roughness and radial overcut. The machining parameters considered in the study are open circuit voltage, discharge current, pulse-on-time, duty factor, flushing pressure and tool material. Fifty four experimental runs are conducted using Inconel 718 super alloy as work piece material and the influence of parameters on each response is analysed. It is observed that tool material, discharge current and pulse on time have significant effect on machinability characteristics of Inconel 718. Finally, a novel MOPSO algorithm has been proposed for simultaneous optimization of multiple responses.

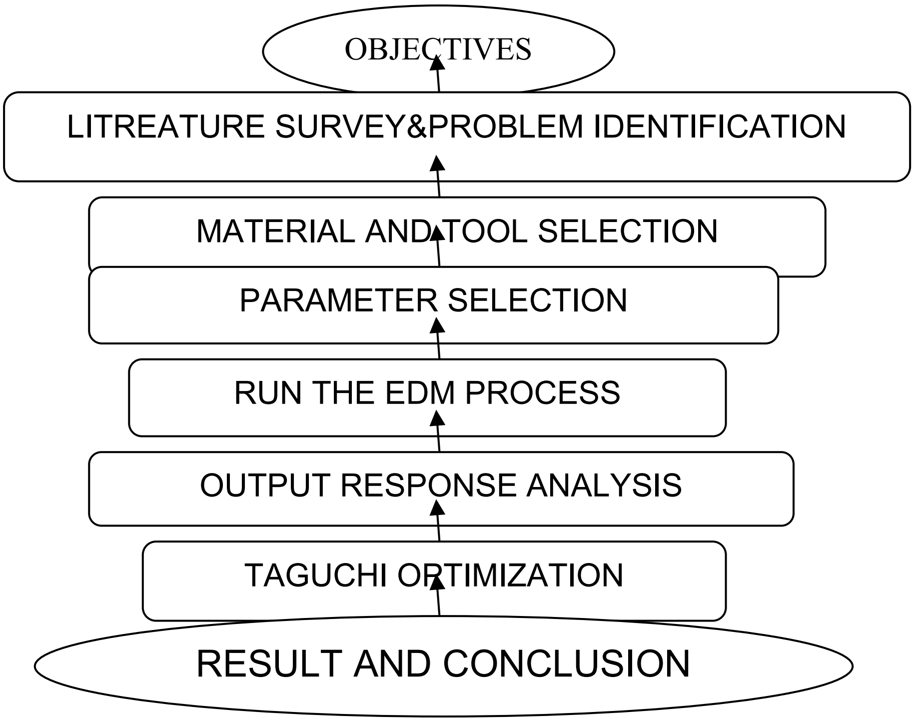
V.D. Bui et al. [9] (2021) used a dielectric combination consisting of silver nanoparticles and electrodes to generate a coating against bacteria on the surface of the workpiece in the biomedical sector. A layer that hardened and included more silver than ordinary evolved through raising the concentration of silver particles in the medium of solution. Also, the results showed an apparent reduction in microbial clusters on the layers containing silver.

Yu Liu et al. [10] (2021) studied by changing four factors: the open-circuit voltage difference, pulse current difference, pulse phase difference, and pulse width difference of the back wave behind the step front. The material removal rate and surface roughness were measured. The research results showed that the material removal rate could be increased to 164.63%, and the material surface roughness could be increased to 30.03% by adjusting the high and low pulse current difference from 1 A to 8 A. When the voltage difference between high and low wave (HLW) pulses increases from 40 V to 120 V, the material removal rate can be increased to 150.39%, and the material surface roughness can be increased to 20.49%. The material removal rate increases with the increase in pulse phase difference and open-circuit voltage difference. With the increase in peak current difference and pulse width difference, the material removal rate becomes faster at first and then slower. The surface roughness of materials increases with the growth of open-circuit voltage difference, peak current difference, pulse width difference, and pulse phase difference.

METHODOLOGY

EXPERIMENTAL PLAN

The proposed work approach and methodology has been elaborately shown in the



CHAPTER-8

1. Objectives

The main objective of this work is to investigate the machining performance of Aluminum Metal Matrix Composite (AMMC) during the Electrical Discharge Machining (EDM) process. The study aims to evaluate machining characteristics such as surface roughness, material removal rate (MRR), machining time, and overcut analysis. The work also focuses on optimizing process parameters to achieve improved machining quality.

2. Literature Survey and Problem Identification

A detailed literature survey was conducted on EDM machining of metal matrix composites and hybrid composite materials. Previous studies related to process parameters, machining characteristics, optimization methods, and reinforcement materials were reviewed. From the literature review, it was observed that machining of hybrid composites still faces challenges such as poor surface finish, lower material removal rate, and dimensional inaccuracies. Therefore, the present work focuses on improving machining performance through parameter optimization.

3. Material and Tool Selection

AA7075 aluminum alloy was selected as the matrix material due to its excellent mechanical properties, low weight, and corrosion resistance. Boron Carbide (B4C) and Silicon Carbide (SiC) were selected as reinforcement materials because of their high hardness and wear resistance properties.

The selected tool material for the EDM process was electrolytic copper because of its good thermal conductivity, electrical conductivity, and lower electrode wear characteristics.

The composite ratios selected are:

Sample 1:
AA7075 + 5% B4C + 2.5% SiC

Sample 2:
AA7075 + 2.5% B4C + 5% SiC

4. Composite Fabrication

The composite specimens were fabricated using the crucible casting process. Initially, AA7075 alloy was melted at the required temperature, and reinforcement particles were added in predetermined proportions. Proper stirring was carried out to ensure uniform distribution of reinforcement particles within the matrix material. The molten mixture was then poured into molds and allowed to solidify.

5. Parameter Selection

The important machining parameters selected for EDM experiments are Pulse ON Time (Ton), Pulse OFF Time (Toff), Gap Current, and Gap Voltage. These parameters were selected because they significantly affect machining performance characteristics.

Two levels of process parameters were considered for conducting experiments.

parameters	**Level 1**	**Level 2**
Pulse ON Time (µs)	30	36
Pulse OFF Time (µs)	6	8
Gap Current (A)	4	6

6. EDM Machining Process

The EDM machining process was carried out using an Electronica EMS 5030 machine setup. The workpiece was fixed properly on the machine table and the copper electrode was mounted on the tool holder. Dielectric fluid was continuously circulated to remove debris and maintain stable spark generation between tool and workpiece. Machining was performed according to the selected parameter settings.

7. Output Response Analysis

After machining, output responses were measured and analyzed. The responses considered for the study include:

- Surface Roughness (Ra)
- Material Removal Rate (MRR)
- Machining Time (MT)
- Overcut Analysis

Material Removal Rate was calculated based on the difference between workpiece weight before and after machining.

Overcut values were measured using a Video Measuring System (VMS).

8. Taguchi Optimization

Taguchi optimization technique was used to determine the optimum process parameter combinations. The Taguchi method helps reduce the number of experiments while improving process efficiency. Signal-to-noise (S/N) ratio analysis was used to identify the influence of process parameters on machining responses.

9. Results and Conclusion

The experimental results obtained from EDM machining were analyzed and compared for both composite ratios. The machining performance was evaluated based on surface roughness, material removal rate, machining time, and overcut values. From the analysis, conclusions were drawn regarding the effect of reinforcement ratio and process parameters on machining performance.

CHAPTER-3

APPLICATIONS OF EDM

3.1 SOME OF EDM USAGE

The Various EDM usages are Micro EDM, EDM Drilling, Abrasive Electro discharge grinding and Wire EDM.

3.1.1 Micro EDM:

Micro EDM, similar to conventional macro EDM, is an erosion process where the material is removed by electrical discharges generated at the gap between two electrically conductive electrodes. Micro EDM is used to machine micro holes, channels and 3D micro cavities in electrically conductive materials including super alloy such as tungsten carbide and stainless steel. Micro EDM has been used to drill not only circular holes but also holes with irregular cross sections. The shape and size of the micro hole made by micro EDM is determined by the electrode prepared by the WEDG. The micro EDM machine used is Panasonic MG-ED72W , This machine includes MG-ED71 (Standard NC Boring machine) + WEDG Unit (Micro Electrode Tooling unit) Recently conducted projects include Integration of Uniform Wear Method with CAD/CAM and Machining of Microhole with high aspect ratio and non circular blind micro hole.

3.1.2 EDM Drilling:

Once relegated to a last resort method of drilling holes, fast hole EDM drilling is now used for production work. Drilling speeds have been achieved of up to 2 ipm. Holes can be drilled in any electrically conductive material, whether hard or soft, including carbide. Fast hole EDM drilling is used for putting holes in turbine blades, fuel injectors, cutting tool coolant holes, hardened punch ejector holes, plastic mold vent holes, wire-EDM starter holes, and other operations. The term fast hole EDM drilling is used because conventional ram EDM can also be used for drilling.

However, ram EDM hole drilling is much slower than machines specifically designed for EDM drilling. Fast hole EDM drilling uses the same principles as ram EDM. A spark jumps across a gap and erodes the work piece material. A servo drive maintains a gap between the electrode and the work piece. If the electrode touches the work piece, a short occurs. In such situations, the servo drive retracts the electrode. At that point the servomotor retraces its path and resumes the EDM process. Recent research investigates the influence of process parameters on the surface integrity of the electro discharge drilling process.

3.1.3 Abrasive Electro Discharge Grinding (AEDG):

AEDG is a hybrid process, which combines EDM and grinding. In AEDG mechanical abrasion of a metal bonded diamond wheel is combined with the electro-erosion of electro discharge machining (EDM). The removal of conductive or partially conductive material is by a combination of rapid, repetitive spark discharges between work piece and rotating tool, separated by a flowing dielectric fluid and also by a mechanical action of irregularly shaped abrasive particles on the periphery of the wheel.

The recent research includes monitoring and control, new power generator, 2-axis NC wheel dressing unit, environmental performance of different dielectric fluids. The current research involves strategy for optimizing neural network modeling, the study of self dressing characteristics and sequence of operations and using neural networks for controls in AEDG.

3.2 ADVANTAGES OF EDM

The main advantages of DM are:

- By this process, materials of any hardness can be machined;
- No burrs are left in machined surface;
- One of the main advantages of this process is that thin and fragile/brittle components can be machined without distortion;
- Complex internal shapes can be machined

3.3 LIMITATIONS OF EDM

The main limitations of this process are:

- This process can only be employed in electrically conductive materials;
- Material removal rate is low and the process overall is slow compared to conventional machining processes;
- Unwanted erosion and over cutting of material can occur;
- Rough surface finish when at high rates of material removal.

CHAPTER-4

MATERIALS & METHODS

4.1ALUMINUM-7075

Al 7075 has a good surface finish; high corrosion resistance is readily suited to welding and can be easily anodized. Most commonly available as T6 temper, in the T4 condition it has good formability.

4.1.1 Chemical composition of Aluminum 7075

Table : 4. 1- Typical Chemical composition for Aluminum Alloy 7075

ELEMENT	**% PRESENT**	
	MIN	**MAX**
Si	-	0.40
Fe	-	0.50
Cu	1.2	2.0
Mn		0.30
Mg	2.1	2.9
Zn	5.1	6.1
Ti	-	0.20
Cr	-	0.28
Al	-	-

4.1.2 AA 7075 Aluminum Mechanical Properties

Table: 4.2 Al7075 mechanical properties

Density	2.8
Melting Point	660.2
Modulus of Elasticity	68.3gpa
Thermal conductivity	0.57cal/Cms°C
Crystal Structure	Fcc
Electrical resistivity	2.69

4.1.3 Machinability

The heat-treated alloy has fairly good machining properties, but tools should preferably be of high speed steel and must be kept sharp. A moderately high rate of tool wear may be expected. Liberal cutting lubricant should be employed.

4.1.4 Casting characteristics

FLUIDITY -Good, suitable for fairly thin castings. PRESSURE TIGHTNESS -Excellent, suitable for castings required to be leak tight

HOT-TEARING -Excellent problems due to hot tearing are rarely seen.

TYPICAL POURING TEMPERATURE -710°C

4.2 SILICON CARBIDE

Table: 4.3 Properties of major SiC polytypes

Polytype	**3C (β)**	**4H**	**6H (α)**
Crystal structure	Zinc blende (cubic)	Hexagonal	Hexagonal
Space group	T^2_d-F43m	C^4_{6v}-$P6_3mc$	C^4_{6v}-$P6_3mc$
Pearson symbol	cF8	hP8	hP12
Density (g/cm^3)	3.21	3.21	3.21
Bulk modulus (GPa)	250	220	220
Thermal conductivity ($W\ cm^{-1}K^{-1}$) @ 300K (see [28] for temp. dependence)	3.6	3.7	4.9

Silicon carbide (SiC), also known as carborundum is a compound of silicon and carbon with chemical formula SiC. It occurs in nature as the extremely rare mineral moissanite. Silicon carbide powder has been mass-produced since 1893 for use as an abrasive. Grains of silicon carbide can be bonded together by sintering to form very hard ceramics which are widely used in applications requiring high endurance, such as car brakes, car clutches and ceramic plates in bulletproof vests. Electronic applications of silicon carbide as light emitting diodes (LEDs) and detectors in early radios were first demonstrated around 1907 and today SiC is widely used in high-temperature/high-voltage semiconductor electronics. Large single crystals of silicon carbide can be grown by the Lely method; they can be cut into gems known as synthetic moissanite. Silicon carbide with high surface area can be produced from SiO_2 contained in plant material.

4.3 BORON CARBIDE

Boron Carbide is one of the hardest materials known, ranking third behind diamond and cubic boron nitride. It is the hardest material produced in tonnage quantities.

Originally discovered in mid-19th century as a by-product in the production of metal borides, boron carbide was only studied in detail since 1930.Boron carbide powder (see figure 1) is mainly produced by reacting carbon with B_2O_3 in an electric arc furnace, through carbothermal reduction or by gas phase reactions. For commercial use B_4C powders usually need to be milled and purified to remove metallic impurities.

Boron carbide is characterized by its:

- Extreme hardness
- Difficult to sinter to high relative densities without the use of sintering aids
- Good chemical resistance
- Good nuclear properties
- Low density

Table 4.4 Typical properties of boron carbide

Property	**Value**
Density ($g.cm^{-3}$)	2.52
Melting Point (°C)	2445
Hardness (Knoop 100g) ($kg.mm^{-2}$)	2900-3580
Fracture Toughness ($MPa.m^{-½}$)	2.9 - 3.7
Young's Modulus (GPa)	450 - 470
Electrical Conductivity (at 25°C) (S)	140
Thermal Conductivity (at 25°C) (W/m.K)	30 - 42
Thermal Expansion Co-eff. $x10^{-6}$ (°C)	5
Thermal neutron capture cross section (barn)	600

4.4 MATERIAL REQUIREMENT FOR CRUCIBLE CASTING

Cylindrical Specimen size-30 mm dia-&Length-250 mm
Rod Size-Dia-30 mm& Length-250 mm(3.14/4 X D2 x L)- Volume-176.63
Mass-=VolumexDensity (176.71x 2,7) = Totally-477 approximately-500 g_

Table: 4.5 Ratio Of both AMMC

Ratio	**AL 7075 grams**	**B4C%&Weight**	**SILICON CARBIDE**
I	500	5%-25Grams	2.5% - 12.5grams
II	500	2.5% - 12.5 grams	5%- 25Grams

4.5 MACHINING PARAMETERS (GENERAL)

The Table 4.6 shows Machining parameters of the EDM setup.

Table: 4.6 Machining Parameters (General)

Voltage (V)	V80±5%
Discharge Current (A)	4,
Servo Control	Electro Mechanical
Polarity	Normal (Electrode – Positive
Dielectric fluid	IPOL fluid
Flushing side	Flushing with Pressure
Work piece Material	AMMC,
Electrode Material	Copper,

4.6 EXPERIMENTAL PROCEDURES

4.6.1 Work piece preparation

The AMMC specimens were prepared for the EDM process 32 mm diameter and 15 mm thickness and 16 Nos total. Specimen weights were calculated with the help of a digital weighing machine. Casted AMMCs rod and specimens were illustrated on Figure 4.1

Figure 4.1 Casted rod and specimen

4.6.2 Tool preparation

The tool material used for the experimentation is electrolytic copper, The copper electrode profiles were measured with the help of video measuring setup for the purpose of over cut deviation analysis after machining process. All electrode weights were measured before machining for the finding purpose material removal rate.

4.6.3 Experimental setup

To conduct experiments with silicon carbide powder mixed dielectric fluid, a separate dielectric recirculation system was designed, fabricated and attached to the machine.

4.7 EXPERIMENTAL SETUP-ELECTRONICA EMS 5030

Figure:4.2 EDM machine setup

The recirculation system consists of a dielectric tank of capacity 4liters, pump and delivery devices. The circulation system consists of a submerged pump with a Rectangular unit. The pump receives the dielectric fluid from the recirculates to the tool-work inter-electrode gap to flush the debris during machining. A fixture is fabricated to hold the work piece of dimensions ø 30 mm × 10 mm in position during the EDM experiments. The fixture is previously fabricated to ensure parallelism of the work piece surface with reference to the machine table.

4.8 COPPER ELECTRODE

Electrodes were machined to a cylindrical shape size of 15 dia 25 mm height.

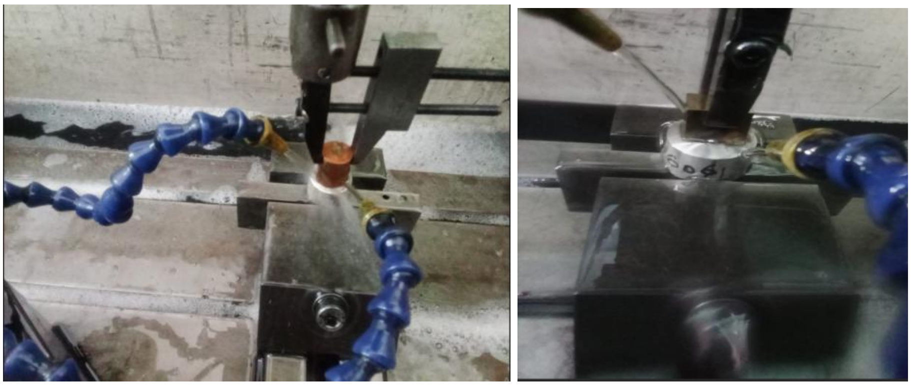


Figure: 4.3 EDM Experimental Setup

4.9 ELECTRODE MATERIALS

Electrode material has a significant influence on important output parameters, such as, material removal rate, surface roughness and dimensional accuracy. Copper and brass are two commonly used EDM electrode materials in the industry because these materials have high melting temperature and excellent electrical and thermal conductivity. Copper can be easily machined to any shape, suffers less wear, has good thermal conductivity, and is economical. Brass is inexpensive and very easy to machine, but it has high electrode wear. It is often used for tubular electrodes in specialized small hole EDM drilling machines where high wear is acceptable. Electrodes made from special powders by using powder metallurgy technology have been used to modify EDM surfaces in recent years and excellent wear and corrosion resistance has been achieved under specific machining conditions. However, this technique is yet to gain wide acceptance. In this research work, we have performed by using birolytic copper.

CHAPTER-5

MACHINING PROCESS AND COMPARATIVE ANALYSIS

5.1 MMC Ratio

The table 5.1 is illustrates of MMC ratio of both composites

Table 5.1 MMC Ratio table

Sample-1	AA7075 +5%B_4C+SiC2.5%
Sample-2	AA7075 +2.5%B_4C+Sci 5%

5.2 PROCESS PARAMETER

The machining parameters were selected to study their effect on the machining performance of both AMMC composites. Four important parameters were considered: **Pulse ON Time, Pulse OFF Time, Gap Current, and Gap Voltage**. The two level and three factors were used to machining the materials for both AMMC's

Table: 5.2 Process parameters levels of both composites

parameters	Level 1	Level 2
Pulse ON Time (µs)	30	36
Pulse OFF Time (µs)	6	8
Gap Current (A)	4	6

Taguchi L4 Orthogonal Array

Experiment No.	**Pulse ON Time (µs)**	**Pulse OFF Time (µs)**	**Gap Current (A)**
1	30	6	4
2	30	8	6
3	36	6	6
4	36	8	4

5.3 AFTER EDM MACHINING IMAGES OF AMMCs

Figure: 5.1 Specimen Image after EDM Process-L16

5.4 EXPERIMENTAL OUTPUT DATA

The three level process parameter were utilized for the both MMC’s and its output responses such as machining parameter and geometrical deviation were mentioned Table 5.5 & 5.6

Table 5.3 Output responses of both Metal matrix- Sample-1

Ex. No	**Pulse ON Time (µs)**	**Pulse OFF Time (µs)**	**Gap Current (A)**	**Surface Roughness (µm)**
1	30	6	4	8.14
2	30	8	6	8.16
3	36	6	6	8.55
4	36	8	4	8.32

Table 5.4 Output responses of both Metal matrix-Sample-2

Experiment No.	Pulse ON Time (µs)	Pulse OFF Time (µs	Current (A)	Surface Roughness (µm)
1	30	6	4	9.79
2	30	8	6	9.52
3	36	6	6	9.63
4	36	8	4	9.58

Table 5.5 Weight calculation for MRR Before and After -Sample-1

S.No	Before weight	After weight	Loss of materials	MT	MRR
1	28.98	28.24	0.74	9.12	0.0811
2	31.87	31.14	0.73	6.31	0.1156
3	30.06	29.17	0.89	5.82	0.1534
4	29.50	28.68	0.82	16.6	0.0494

Table 5.6 Weight calculation for MRR Before and After --2

S.No	Before weight	After weight	Loss of materials	MT	MRR
1	29.04	28.41	0.64	11.02	0.0580
2	29.53	28.77	0.76	8.41	0.0904
3	28.11	27.45	0.66	7.42	0.0889
4	30.02	29.21	0.81	7.95	0.1019

5.5 PARAMETER Vs SURFACE ROUGHNESS

The initial parameter, concerning the maximum percentage of Boron carbide in the Ratio -1 Metal Matrix Composite (MMC) attained during the Electrical Discharge Machining (EDM) process, involves lower levels of TON, TOFF, and a minimum amperage rating, which results in a reduction of the roughness value to 8.16 µm. Throughout this process, the predominant reinforcement of Silicon carbide percentage ratio influences the maximum surface roughness.

Figure: 5.2 Graphical representation Parameter Vs Roughness average

5.6 PARAMETER Vs MACHINING TIMING

The minimum machining time is observed on the third specimens with the highest percentages of maximum boron carbide at Ratio-1 during the EDM process, which is attained through increased pulse on, pulse off, and elevated gap current and voltage

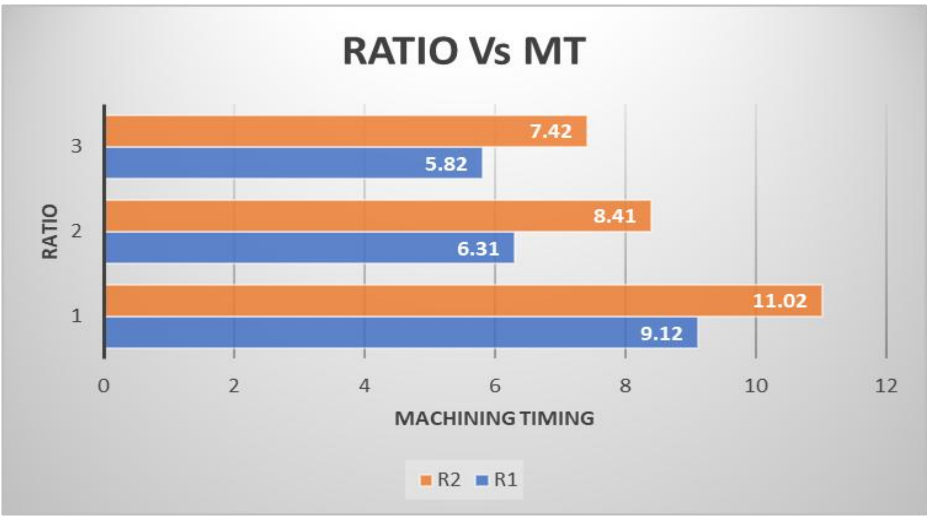


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Figure: 5.3 Graphical representation Parameter Vs MT

5.7 PARAMETER Vs MRR

The higher MRR held on higher percentages of Boron carbide composites ratio observed duration is observed on the third specimens with the highest percentages of carbide at Ratio-1 during the EDM process, which is attained by utilizing elevated pulse on and pulse off times, as well as increased gap current and voltages.

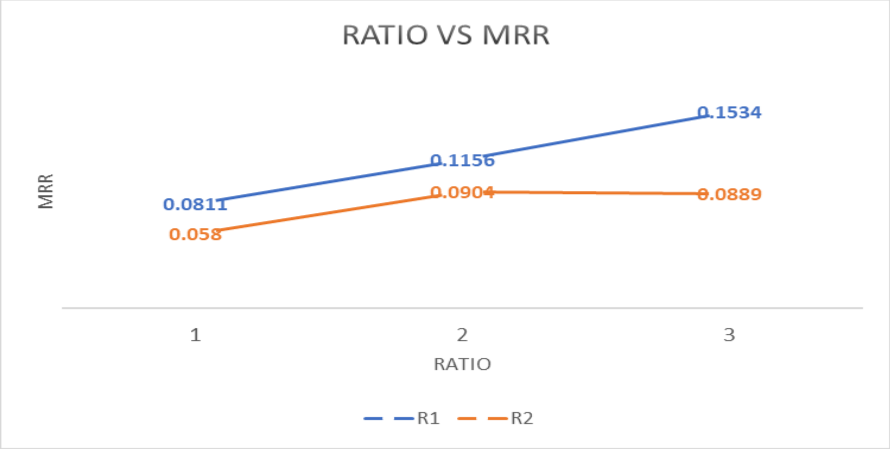


Figure: 5.4 Graphical representation Parameter Vs MRR

5.8 OVER CUT ANALYSIS OF EDM PROCESS

Overcut values were found using Video measuring setup. The below mentioned Figure 5.5 shows the VMS.

Figure: 5.5 Video Measuring setup

Overcut values were determined using processed EDM samples both AMMC the below mentioned table illustrated the values.

Table: 5.7 Over cut values of Ratio-1 B_4C+Sic AMMC alloys during EDM process

S.NO	**T.ON (µs)**	**T.OFF (µs)**	**GAP CURRENT (Amps)**	**ELECTRODE DIA& IMPRESSION DIA**		**DEVIATION in mm**
1	30	6	4	18.7807	19.0944	0.3097
2	30	8	6	18.7807	19.1104	0.3297
3	36	6	6	18.7807	19.0493	0.2686
4	36	8	4	18.7807	19.0847	0.3040

Table: 5.8 Over cut values of Ratio-1 Sic+ B_4C AMMC alloys during EDM process

S.NO	T. ON (µs)	T.OFF (µs)	GAP CURRENT (Amps)	ELECTRODE DIA& IMPRESSION DIA		DEVIATION in mm
1	30	6	4	18.7807	19.0570	0.2763
2	30	8	6	18.7807	19.0524	0.2717
3	36	6	6	18.7807	19.0565	0.2758
4	36	8	4	18.7807	19.0565	0.2746

In the EDM research investigation, the EDM process's minimum overcut value was found to be 0.2763 mm on Ratio -2 at first parameter. During the process, the minimum overcut induced by the minimum T-ON&T-OFF and current but voltage is maximum. The overcut value for the EDM process was plotted and compared in the graphical representation shown in fig. 5.9.

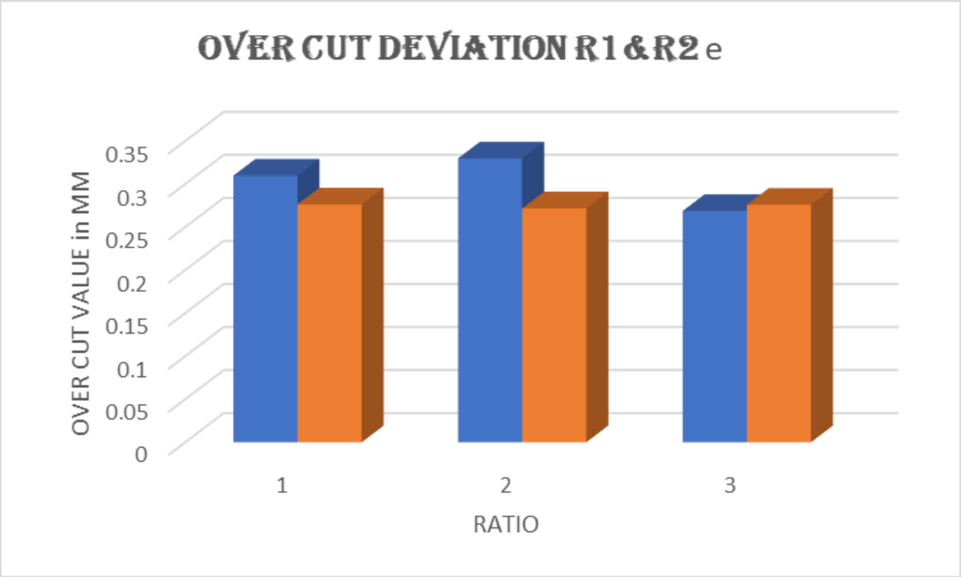
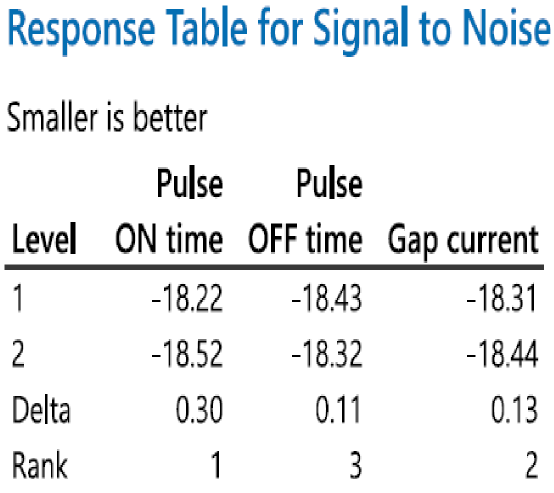


Figure: 5.6 Graphical representation of overcut value

5.9 S-N RATIO ANALYSIS

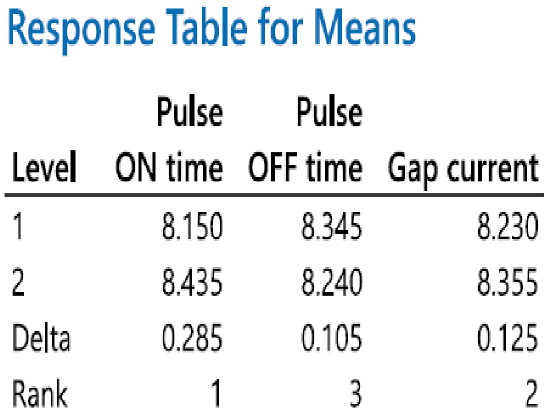
9.9.1 Experimental Result Table for SN Ratio of sample 1- surface Roughness



Response Table for Signal to Noise Ratios

Smaller is better

Level	Pulse ON time	Pulse OFF time	Gap current
1	-18.22	-18.43	-18.31
2	-18.52	-18.32	-18.44
Delta	0.30	0.11	0.13
Rank	1	3	2

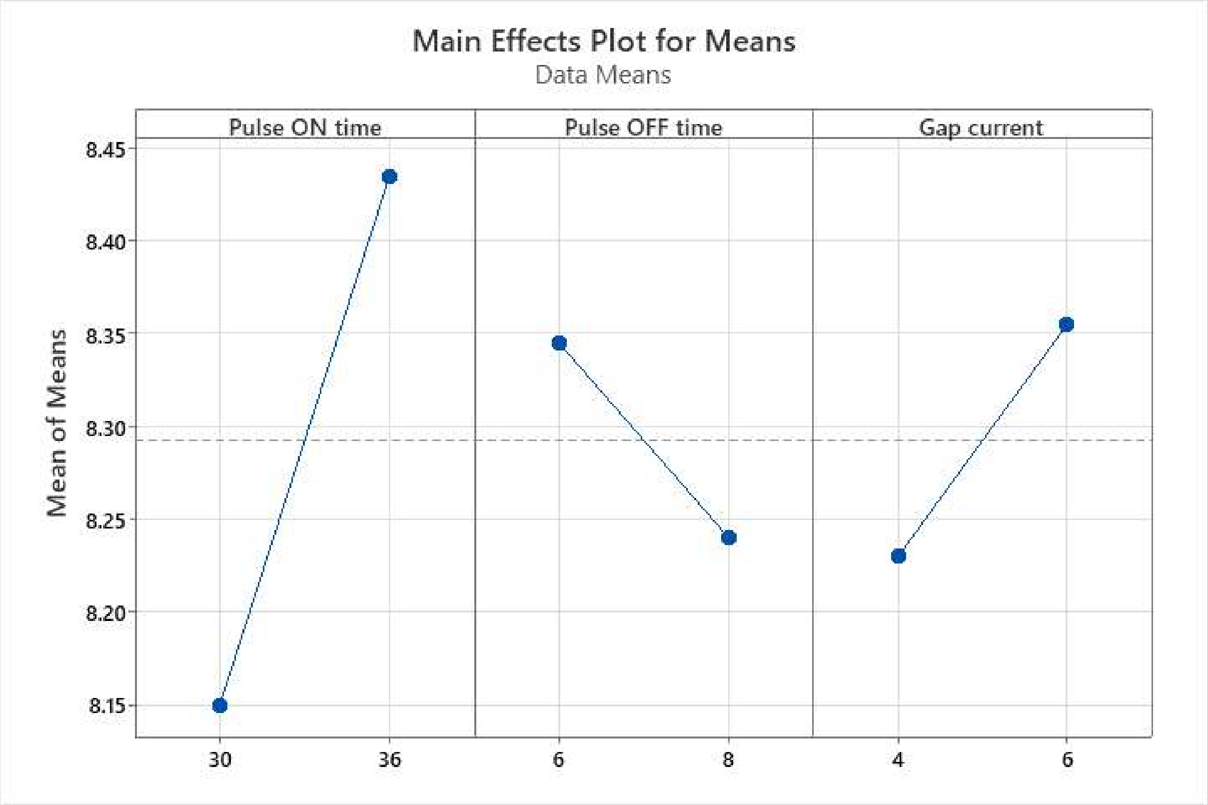


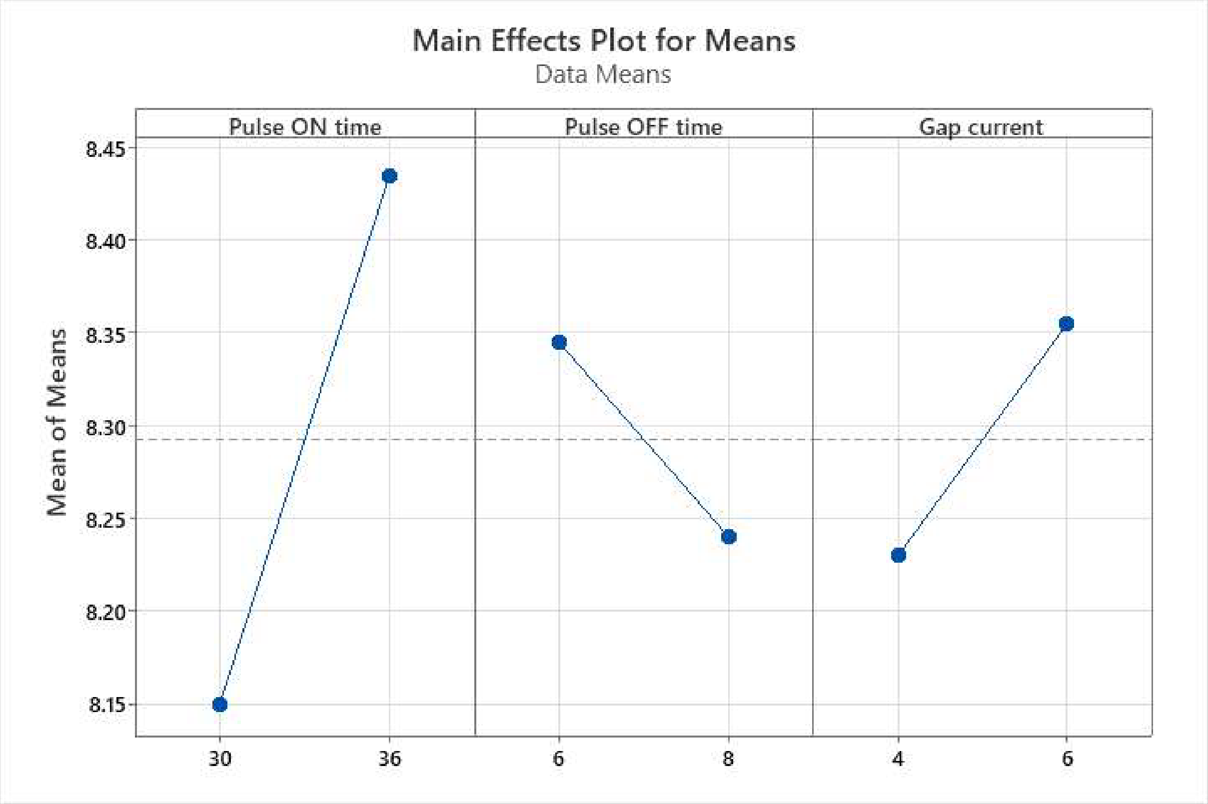
Response Table for Means

Level	Pulse ON time	Pulse OFF time	Gap current
1	8.150	8.345	8.230
2	8.435	8.240	8.355
Delta	0.285	0.105	0.125
Rank	1	3	2

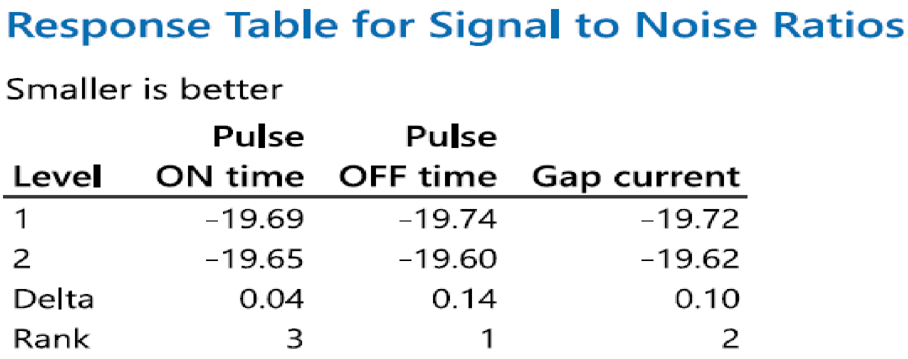
5.9.2 GRAPHICAL ANALYSIS

5.9.3 Sample 1- Surface Roughness (Ra) vs Experiment Number





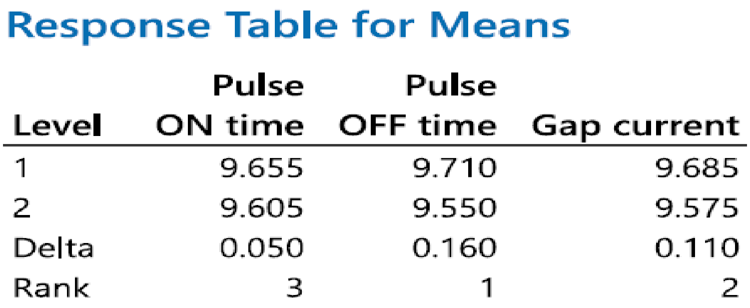
5.9.4 Experimental Result Table for SN Ratio of sample 2- surface Roughness



Response Table for Signal to Noise Ratios

Smaller is better

Level	Pulse ON time	Pulse OFF time	Gap current
1	-19.69	-19.74	-19.72
2	-19.65	-19.60	-19.62
Delta	0.04	0.14	0.10
Rank	3	1	2

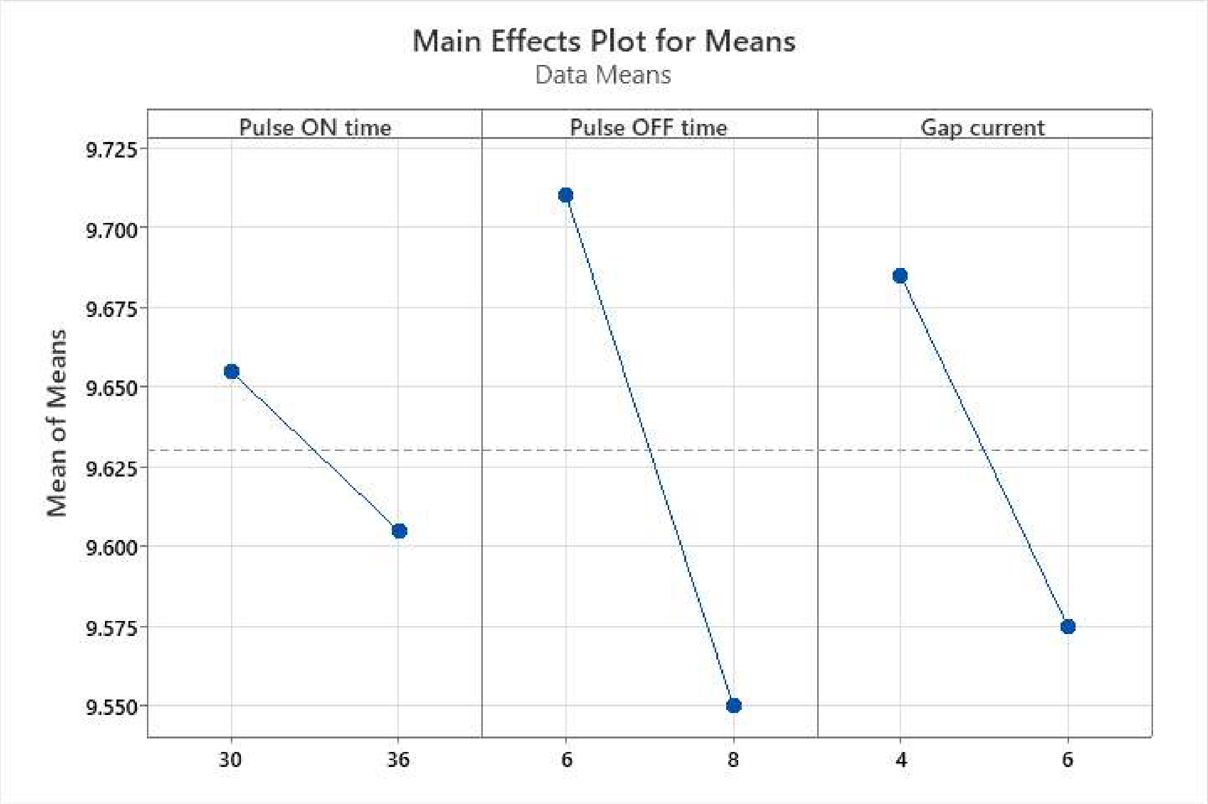


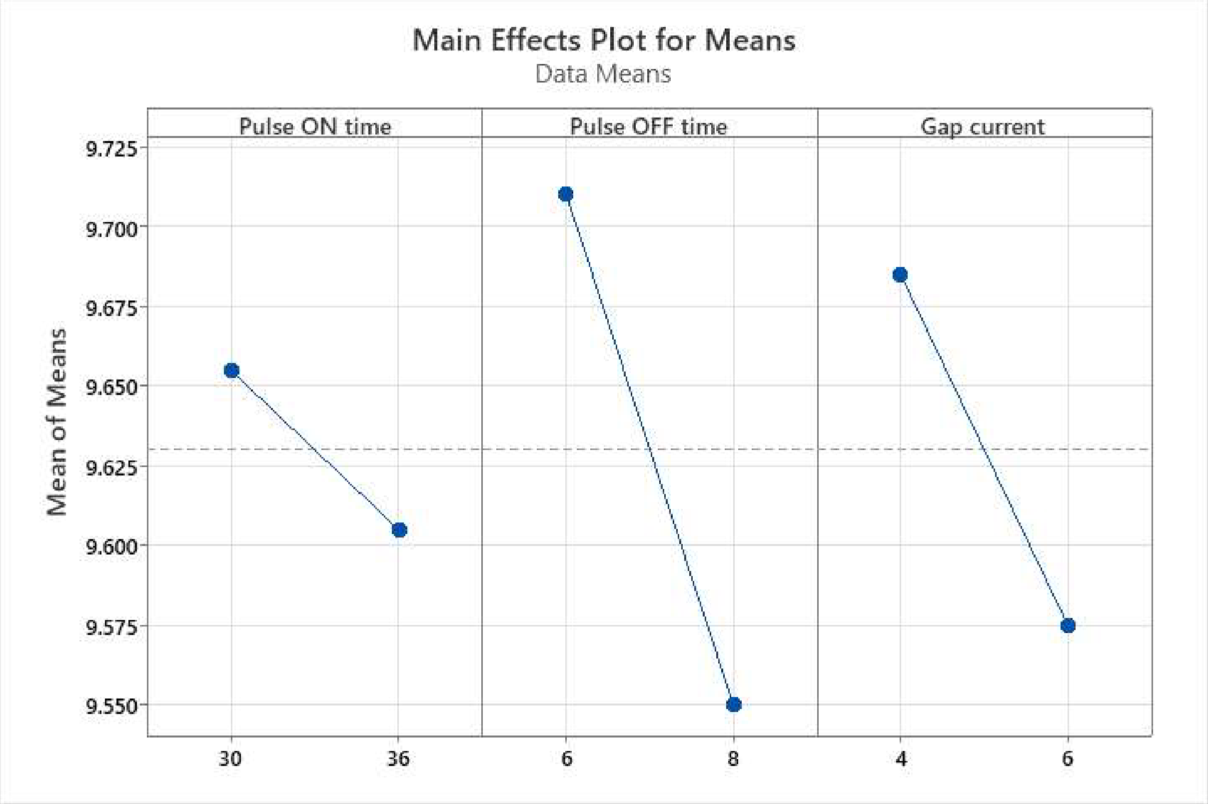
Response Table for Means

Level	Pulse ON time	Pulse OFF time	Gap current
1	9.655	9.710	9.685
2	9.605	9.550	9.575
Delta	0.050	0.160	0.110
Rank	3	1	2

5.9.5 GRAPHICAL ANALYSIS

5.9.6 Sample 2- Surface Roughness (Ra) vs Experiment Number





5.9.7 Experimental Result Table for SN Ratio of sample 1 - MRR

CHAPTER-6

MICROSTRUCTURE ANALYSIS

6.1 SCANNING ELECTRON MICROSCOPY

Scanning electron microscopy, the utilization of Scanning Electron Microscopy

(SEM) played a crucial role in identifying and analyzing the various failure modes present in a composite specimen. Scanning Electron Microscope (SEM)

(Make–Zeiss; Model –EVO 18 Special Edition) was used. ASCP was coated with gold using ion sputtering. Such coating makes the specimen conductive and also avoids charging of the specimen due to its prolonged exposure to the electron beam. It facilitated the conduction of electricity within the specimen and prevented the buildup of charge that could result from prolonged exposure to the electron beam.

Figure 6.1 Zeiss; Model –EVO 18

The SEM analysis was carried out under low-pressure conditions to create an environment conducive to electron beam interactions and signal detection. Operating at low pressure reduces the likelihood of electron scattering and enhances image resolution, thus enabling the visualization of fine details on the sample's surface. Each hybrid composite material was cut to ASTM E407 standard. It had a magnification factor of 100 X to 2 KX.

6.2 MICROSTRUCTURAL BEHAVIOUR ANALYSIS OF R1& R2

Using SEM, a microstructure examination, both ratios of the cross-section view were detected. Attainment of uniform distribution of reinforcement in the matrix and avoiding the chances of agglomeration is the primary objective for the development of material.

R1- AA7075 +5%B_4C+SiC2.5%

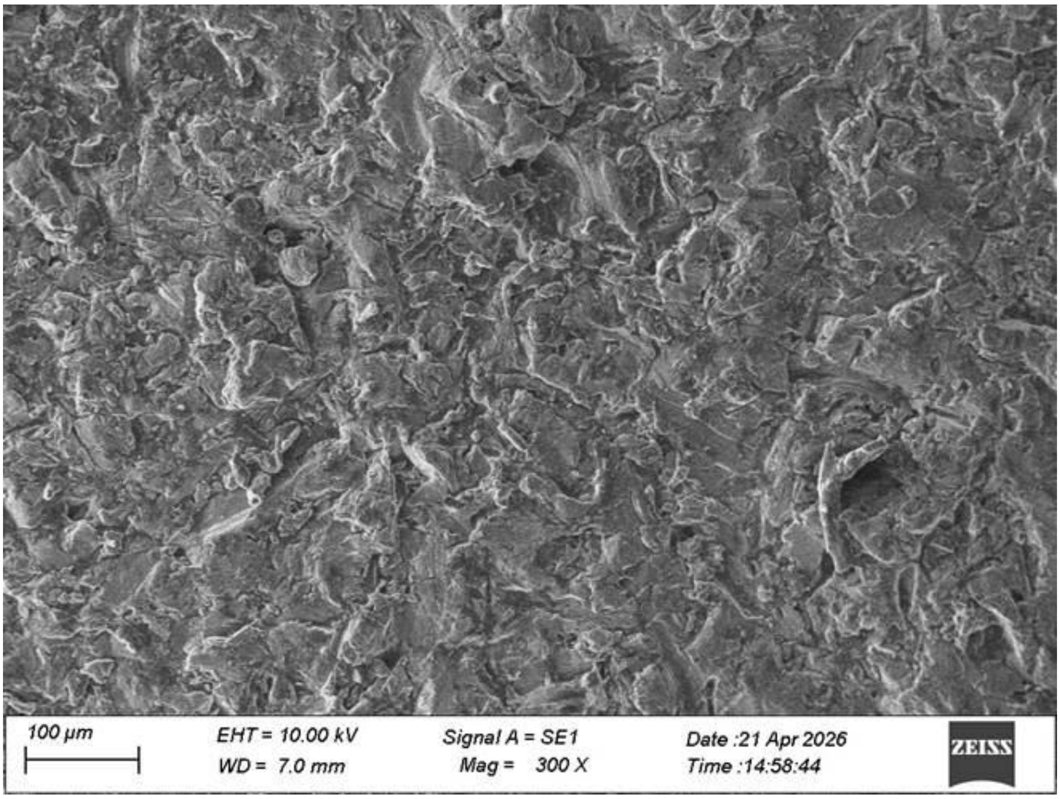


Fig 6.1 SEM Analysis - R1- AA7075 +5%B_4C+SiC2.5%

For microstructural analysis optical micrographs and SEM images have been taken. It revealed the well infiltrated composites (5% of B_4C& 2.5 SiC with uniform particle distribution and no apparent porosity or significant casting defects. This can be verified by microstructural analysis with the help of optical microscopy, SEM.

R2-AA7075+2.5%B_4C+Sci5%

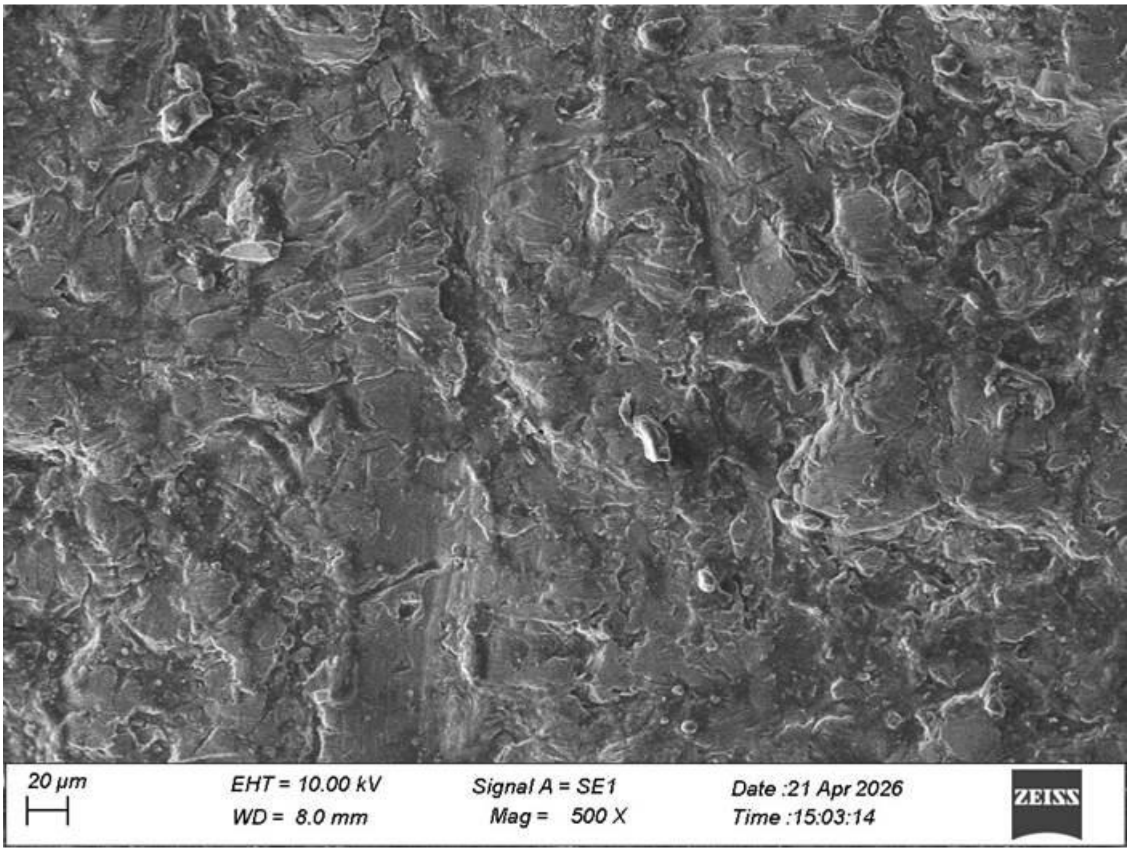


Figure 6.2: SEM Analysis - R2- AA7075+2.5%B_4C+Sci5%

The microstructure analysis reveals that both intra-granular and inter-granular components of the alloy matrix contain uniformly dispersed 2.5%B_4C+Sci5% particles. SEM revealed uniform dispersion for maximum reinforcement composition reinforcement possesses small clustering, which may be due to the stirring process. It is also found that there was a strong intermetallic bonding and excellent wettability along with uniform dispersion.

6.2 Hardness Test

The hardness test was conducted to determine the resistance of the fabricated composite material against indentation and localized plastic deformation. Hardness is an important mechanical property because it indicates the material's wear resistance and strength characteristics. The Rockwell hardness test method was selected because of its simplicity and ability to provide direct hardness values.

6.2.1 Test Specification

Parameter	Specification
Test Method	Rockwell Hardness Test
Scale	B Scale Balls
Indenter	1/16” Stress Ball
Applied Load	100 Kgf
Dial Used	Red Dial
Number of Trials	4

6.3 Experimental Results

6.3.1 Rockwell Hardness Test Results of AA7075–SiC + B_4C AMMC Composite

S.No	Scale	Indenter	Load (kgf)	Dial	(HRB)
1	B	1/16" Ball	100	Red	12.0
2	B	1/16" Ball	100	Red	10.5
3	B	1/16" Ball	100	Red	10.0
4	B	1/16" Ball	100	Red	10.0

Average 10.63

6.3.2 Calculation for sample 1

Average hardness value:

Average Hardness=12+10.5+10+10 / 4

=10.63 HRB

6.3.3 Rockwell Hardness Test Results of Sample 2

S.No	Scale	Indenter	Load (kgf)	Dial	(HRB)
1	B	1/16" Ball	100	Red	8.0
2	B	1/16" Ball	100	Red	11.5
3	B	1/16" Ball	100	Red	11.0
4	B	1/16" Ball	100	Red	12.5

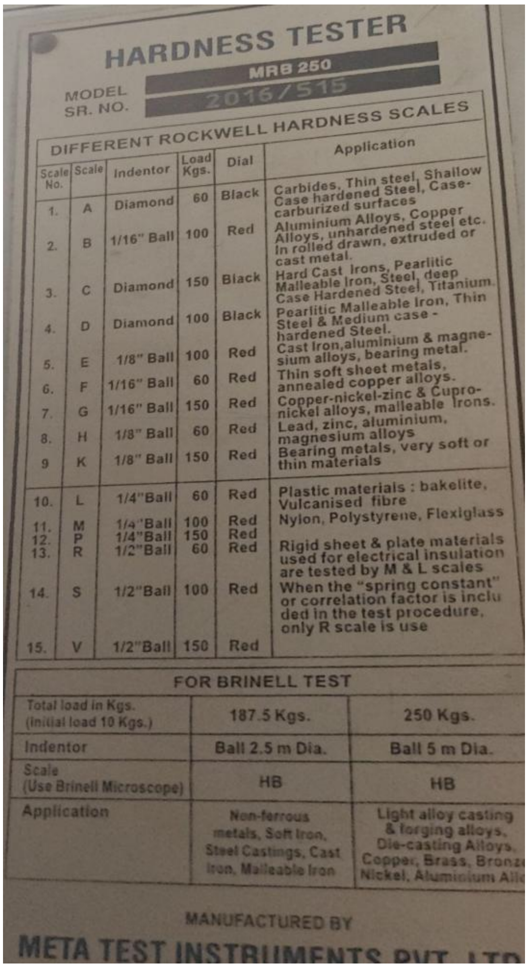
Average 10.75

6.3.4 Calculation for Sample 2

Average hardness value:

Average Hardness = 8+11.5+11+12.5/4

=10.75 HRB.



HARDNESS TESTER

MODEL MRB 250
SR. NO. 2016/515

DIFFERENT ROCKWELL HARDNESS SCALES					
Scale No.	Scale	Indentor	Load Kgs.	Dial	Application
1.	A	Diamond	60	Black	Carbides, Thin steel, Shallow Case hardened Steel, Case-carburized surfaces
2.	B	1/16" Ball	100	Red	Aluminium Alloys, Copper Alloys, unhardened steel etc. In rolled drawn, extruded or cast metal.
3.	C	Diamond	150	Black	Hard Cast Irons, Pearlitic Malleable Iron, Steel, deep Case Hardened Steel, Titanium.
4.	D	Diamond	100	Black	Pearlitic Malleable Iron, Thin Steel & Medium case - hardened Steel.
5.	E	1/8" Ball	100	Red	Cast Iron,aluminium & magnesium alloys, bearing metal.
6.	F	1/16" Ball	60	Red	Thin soft sheet metals, annealed copper alloys.
7.	G	1/16" Ball	150	Red	Copper-nickel-zinc & Cupro-nickel alloys, malleable Irons.
8.	H	1/8" Ball	60	Red	Lead, zinc, aluminium, magnesium alloys
9	K	1/8" Ball	150	Red	Bearing metals, very soft or thin materials
10.	L	1/4"Ball	60	Red	Plastic materials : bakelite, Vulcanised fibre
11.	M	1/4"Ball	100	Red	Nylon, Polystyrene, Flexiglass
12.	P	1/4"Ball	150	Red	
13.	R	1/2"Ball	60	Red	Rigid sheet & plate materials used for electrical insulation are tested by M & L scales
14.	S	1/2"Ball	100	Red	When the "spring constant" or correlation factor is inclu ded in the test procedure, only R scale is use
15.	V	1/2"Ball	150	Red	

FOR BRINELL TEST		
Total load in Kgs. (initial load 10 Kgs.)	187.5 Kgs.	250 Kgs.
Indentor	Ball 2.5 m Dia.	Ball 5 m Dia.
Scale (Use Brinell Microscope)	HB	HB
Application	Non-ferrous metals, Soft Iron, Steel Castings, Cast Iron, Malleable Iron	Light alloy casting & forging alloys, Die-casting Alloys, Copper, Brass, Bronz Nickel, Aluminium All

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CHAPTER-7

RESULT AND CONCLUSION

The aim of the research work was to investigate the machinability of hybrid AA6082 AMMC through die sink mixed EDM. In this study, three process parameters are varied viz.

7.1 RESULTS OF RESEARCH

1. The primary parameter related to the maximum percentage of Boron carbide in the Ratio -1 Metal Matrix Composite (MMC) achieved during the Electrical Discharge Machining (EDM) process includes reduced levels of TON, TOFF, and a minimum amperage rating, leading to a decrease in the roughness value to 8.16 µm
2. The minimum machining time is observed on the third specimens with the highest percentages of maximum boon carbide at Ratio-1 during the EDM process, which is attained through increased pulse on, pulse off, and elevated gap current and voltage
3. The higher MRR held on higher percentages of Boron carbide composites ratio observed duration is observed on the third specimens with the highest percentages of carbide at Ratio-1 during the EDM process, which is attained by utilizing elevated pulse on and pulse off times, as well as increased gap current and voltages.
4. In the EDM research investigation, the EDM process's minimum overcut value was found to be 0.2763 mm on Ratio -2 at first parameter. During the process, the minimum overcut induced by the minimum T-ON&T-OFF and Current but voltage is maximum

7.2 RESEARCH CONCLUSION:

For both the AA7075 composite material matrix and reinforcement, the same EDM machining parameters were set, such as the ratio -1 of 5% boron carbide and 2.5% silicon carbide at the same ratio -2 of 5% silicon carbide and 2.5% boron carbide for the MMC preparation. For both composite ratios and all specimens, a 1 mm depth of cut was predicted during the machining process, following the computation of the roughness average, machining timing, and MRR. An outstanding machining quality was attained by increasing the MMC's boron carbide ratio %. When compared to higher percentages of AMMC with silicon carbide identified during investigation, the machinability characteristics of AMMC reinforced with boron carbide significantly improved.

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