Study on mechanical properties of AMMC and optimization of WEDM process parameters

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KEYWORDS

WEDM,
MRR,
GRA,
ANOVA.

ABSTRACT

The combination of Al7475 base metal and 3% wt. of Boron Nitride, Titanium carbide and Tungsten carbide reinforcements as Metal matrix composites are developed in the current experiment with stir casting process. Up to 1% wt. BN improves mechanical properties beyond this limit, the properties declined due to presence of porosity. The Tensile, Compression, hardness and electrical conductivity of the composites were tested and results compared. Taguchi's design of experiments (L_9) were conducted to optimize the Wire Electrical Discharge Machining (WEDM) process parameters i.e., Pulse on (T_{oN}), Pulse off (T_{off}), Input current (I/c) and Wire feed (W_f) to regulate output responses of Kerf width (Kw) and Metal Removal Rate (MRR). With the help of Grey Relational Analysis (GRA), the optimal values for both MRR and Kerf width were determined as pulse on-95 sec, pulse off -30 sec, input current-1Amperes and wire feed-25 m/min. By analyzing the ANOVA results, it is determined that the input current has the most influencing parameter with contribution of 63.67%.

1. Introduction

Metal matrix composites (MMCs) are a composite material developed by combining the metal matrix and reinforcing phases. Aluminum Metal Matrix Composites, which have many qualities like low density, improved corrosion resistance, high abrasion and wear resistance, high thermal conductivity, and high specific modulus, are employed in this study. These metal matrix materials are used in various sectors including the automotive, marine, nuclear and aerospace ones. In this work Boron nitride (BN), Tungsten carbide (WC) and Titanium carbide (TiC) are considered as reinforced materials because of these materials having desirable properties suitable for selected Al7475 as base material. The purpose of using stir casting is to minimize casting faults and ensure that reinforcement materials are properly mixed with the A7475 base material. Hashim et al. (1999) explained various methods which are employed for the fabrication of aluminum metal matrix composite and also the authors explained process mixing the base metal and reinforced materials through stir casting process. After the casting process the components are evaluated mechanical and electrical properties such as tensile strength, compression strength, Hardness and electrical conductivity etc. The mechanical properties of tensile and compression strength, and by changing different weight percentage of reinforcement materials. In EDM, the metal removal rate (MRR) and Kerf width are estimated by considering Pulse on, Pulse off, Input current, and wire feed as process parameters. The experiments were carried out using a L_9 orthogonal array based on the Taguchi design principle.

Khanna et al. (2021) explained the fast advancements in the mechanical industry constantly place a demand for new and dependable materials. Metal matrix composites (MMCs) are one of the most prominent candidates to perform indispensable jobs in the Mechanical industry. Chandrashekar et al. (2018) studied with the castings prepared with Nano Al_2O_3 reinforced exhibited higher hardness and tensile strength of 96 HV and 264 MPa compared to 76 HV and 210 MPa of base metal, respectively, which was due to Al_2O_3 reinforcements. The static immersion corrosion tests of AMMCs in 3.5% wt.

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Table 2.1
Chemical composition.

Element	Aluminum	Zinc	Magnesium	Chromium	Silicon
Content(%)	90.3	5.7	2.3	0.22	1.5

Table 2.2
Properties.

Properties	Density	Melting point	Elastic modulus	Poisson's ratio	Elongations at break	Modulus of elasticity
Metric	2.6-2.8g/cm^3	546°C	70-80GPa	0.33	12%	71.7GPa

Sahu et al. (2016) proposed work has been made to provide a literature review on the basic existing techniques used to fabricate the Aluminium based MMCs and suggest a least expensive method for the scientific and technical applications. Mondolfo (1976) discussed on the aluminium alloy usage in advanced applications was highlighted because of their combination of high strength, low density, durability, machinability, availability and the cost is also very attractive compared to competing materials.

Walikar and Patil (2015) explained on silver Nano particles are synthesized by chemical reduction process that is Turkevich method. By varying Silver Nano particles by 3, 5 and 7% in composite the external particle morphology is done by SEM and Electrical Properties, hardness, thermal Properties, erosion properties are studied. The hardness, electrical conductivity, thermal conductivity increases as percentage of silver NP increases whereas erosion rate decreases. Imran and Khan (2019) proposed work taken out on fabrication of the aluminum metal matrix composite materials by combining alloys and reinforcements.

Koti et al. (2016) investigate and study the mechanical properties of B_4C reinforced AA7475 alloy metal matrix composites. The Al 7475 alloy was taken as the base matrix and B_4C particulates as reinforcement material to prepare metal matrix composites by stir casting method. For composites the reinforcement material was varied in wt. %. Mechanical properties like hardness, ultimate tensile strength, and yield strength were evaluated as per ASTM standards. Hardness, ultimate tensile strength and yield strength increased as wt. % of B_4C increased in the base matrix.

Jain et al. (2019) Aluminum metal matrix composites are widely used in automobile and aerospace applications due to their low density and excellent strength to weight ratio. Al-SiC metal matrix composites meet most of the requirements of the automobile, electrical and aerospace industries. This paper is an outcome of the development of Al610-SiC metal matrix composite. In this study, the Al-SiC metal matrix composite is manufactured using stir casting technique with amoun to silicon carbide ranging from 8% to 15 % by weight.

2. Material Selection and Methods

2.1 Material

Al 7475 aluminum alloy is a wrought alloy with high zinc weight percentage. It also contains magnesium, silicon and chromium. 7475 alloy cannot be welded. It has more spring back because of its strength. It has high machinability. so it is used as a matrix base material.

2.2. Blending powders

Tungsten carbide (chemical formula: WC) is a chemical compound (specifically, a carbide) containing equal parts of tungsten and carbon atoms. In its most basic form, tungsten carbide is a fine gray powder, but it can be pressed and formed into shapes through sintering for used in industrial machinery, cutting tools, chisels, abrasives, armor-piercing shells and jewelry.

Structure of Tungsten

Carbide

Tungsten carbide (WC) is an inorganic non-natural compound composed of tungsten (W) and carbon (C). Mono-tungsten carbide (WC), which is stable at room temperature, is of major technical relevance. WC exhibits a hexagonal structure made of a grid of tungsten and carbon.

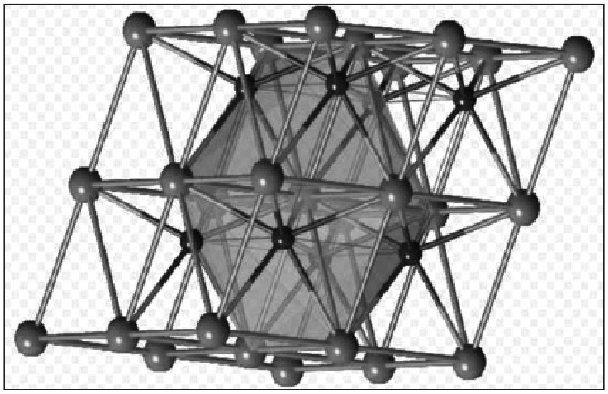


Fig. 2.1. Structure of WC.

Fig. 2.2. WC powder.

3. Fabrication of AMMC

- ❖ The matrix material used for the MMCs in this work is aluminum alloy 7475.
- ❖ This alloy is best suited for light weight metal castings.
- ❖ Aluminium alloy 7475 has numerous benefits like formability, weld ability, and lowcost.
- ❖ The different process parameters are identified in different reinforcement like TiC/WC/BN of constant composition wt.% - 3% of aluminium (1,2&3) and Stirrer speed (While slow mixing of rpm (A, B & C) were used and Stirrer speed of 200 rpm were used with Melting temperature of 900°C).

Table 3.1
Compositions of samples.

S.no	Sample	3% of Reinforcement
1	A	TiC(3%)
2	B	TiC+WC(1.5%+1.5%)
3	C	TiC+ WC+ BN(1%+1%+1%)

3.1. Flow chart

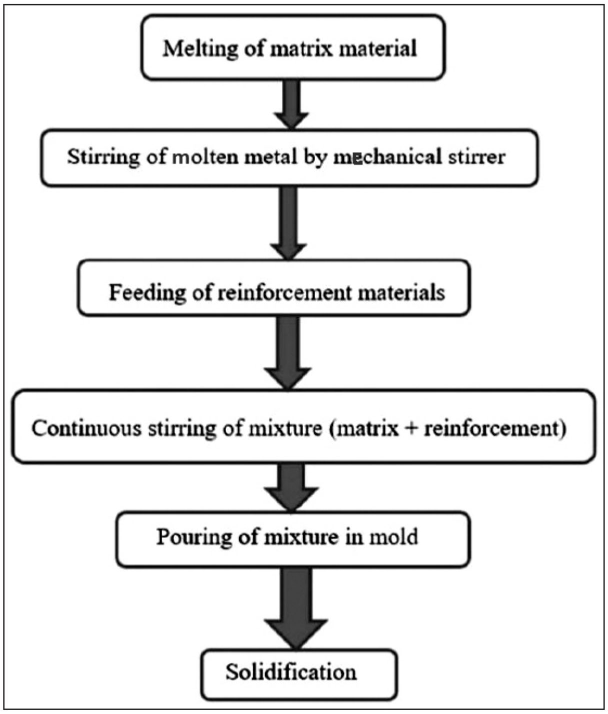


Fig. 3.1. Steps in fabrication.

3.2 Graphite crucible

A graphite crucible (Fig 3.2) is a refractory container used for melting the metals in foundry. These crucibles can with stand temperatures high enough to melt or otherwise alter its contents. They have been made up of any material which is a higher temperature resistance than the substances they are designed to hold. In this work graphite crucible is used.

Fig. 3.2. Graphite crucible.

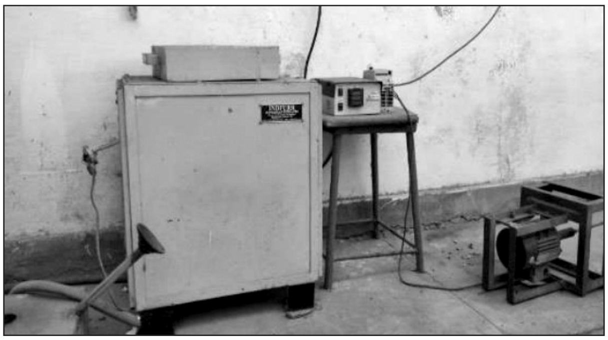


Fig. 3.3. Stir casting setup.

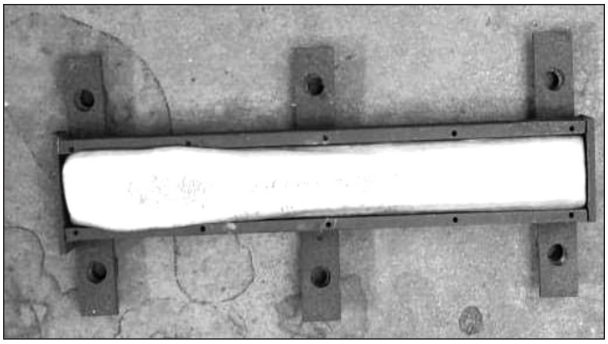


Fig. 3.4. Casted mold piece.

3.3. Wire electrical discharge machining

Electrical discharge machining (EDM), also known as spark machining process. The desired shape is obtained by using electrical discharges (sparks). Material is removed from the work piece by a series of rapidly recurring current discharges between two electrodes, separated by a dielectric liquid and subject to an electric voltage. One of the electrodes is called the tool-electrode, or simply the tool or electrode, while the other is called the work piece-electrode, or work piece. The process depends upon the tool and work piece not making physical contact. When the voltage between the two electrodes is increased, the intensity of the electric field in the volume between the electrodes becomes greater, causing dielectric breakdown of the liquid, and produces an electric arc. As a result, material is removed from the work piece.

- **General components of WEDM**

SMART CUT wire cut EDM machines comprise

- Machine tool
- Pulse generator
- Coolant unit

(a) Machine tool

- Machine tool mainly comprises the work table, normally referred to as X, Y table axis quill with motor, automatic wire tension unit with rollers, and others.
- Means of stepper motors. The auxiliary table parallel to the X-Y table also moves using stepper motors.
- The machine is capable of producing the taper cutting of +/-10 degree over 50mm with the movement of the auxiliary table.

(b) Pulse Generator

- SC01 generator comprises windows - based user-friendly screen to operate the machine.
- Electrical piece and the traveling wire electrode, to cause the electro erosion of the work piece material.

(C) Tank

- The coolant tank contains soft water for cooling and faith-full sparking.
- In the coolant tank, 10-micron paper filters are used for the filtration of coolant.

The prototype of the WEDM machine is shown in the figure below 3.5 and the specifications of the machine are tabulated in the below tabular column 3.2.

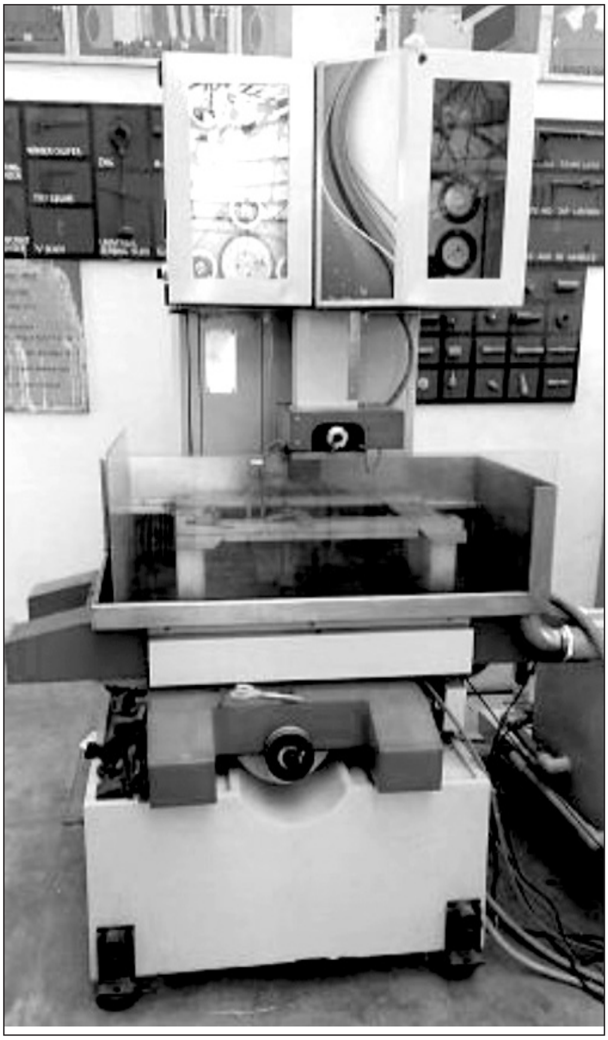


Fig. 3.5. WEDM machine.

Table 3.2
WEDM specifications.

PARAMETER	2530 SMART CUT
Work Table size	500 mm x 400 mm
XY Transverse	250 mm x300 mm
Max. Z height	200 mm
Max Taper angle	+/-10 degrees / 100 mm
Max work piece weight	300 kgs
Dielectric tank capacity	200 litres
Floor plan	2100 mm x 2100 mm x 2050 mm

Fig. 4.1. Universal testing machine.

4. Testing of Mechanical Properties

4.1 Introduction

This chapter deals with the analysis of experimental data obtained from various tests like the tensile test, compression test, hardness test, and electrical conductivity test. The results are discussed through tables and graphs are in the following sections.

4.2 Tensile strength

To know the tensile behaviour of the material tensile testing is used. The tensile strength of the material is varied by the different compositions. The three specimens have the different ultimate strengths, yield strength, young's modulus, percentage elongation and percentage reduction which are all measured by the universal testing machine. Table 4.1 shows summary of the discussed results.

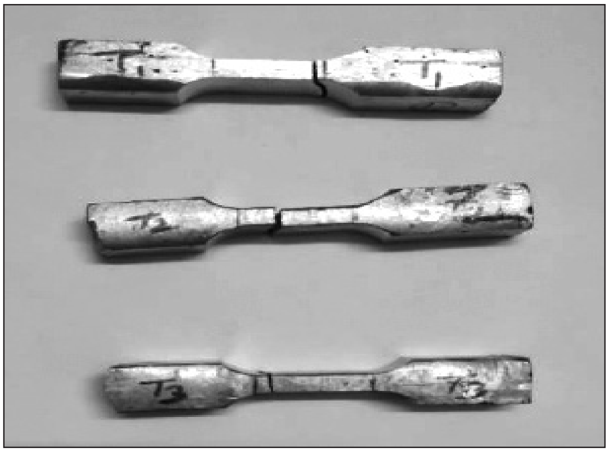


Fig. 4.2. Tested specimens.

Table 4.1
Tensile strength test results of AMMC composites.

Sample No	Composition	Tensile Strength (MPa)	Yield Strength (MPa)	Elongation (%)
1	AL 7475(97%) +TiC (3%)	31.65	19.55	6.20
2	AL 7475(97%) +TiC (1.5%) +WC (1.5%)	40.64	20.18	4.48
3	AL 7475(97%) +TiC (1 %) +WC (1 %) +BN (1%)	91.76	63.19	6.48

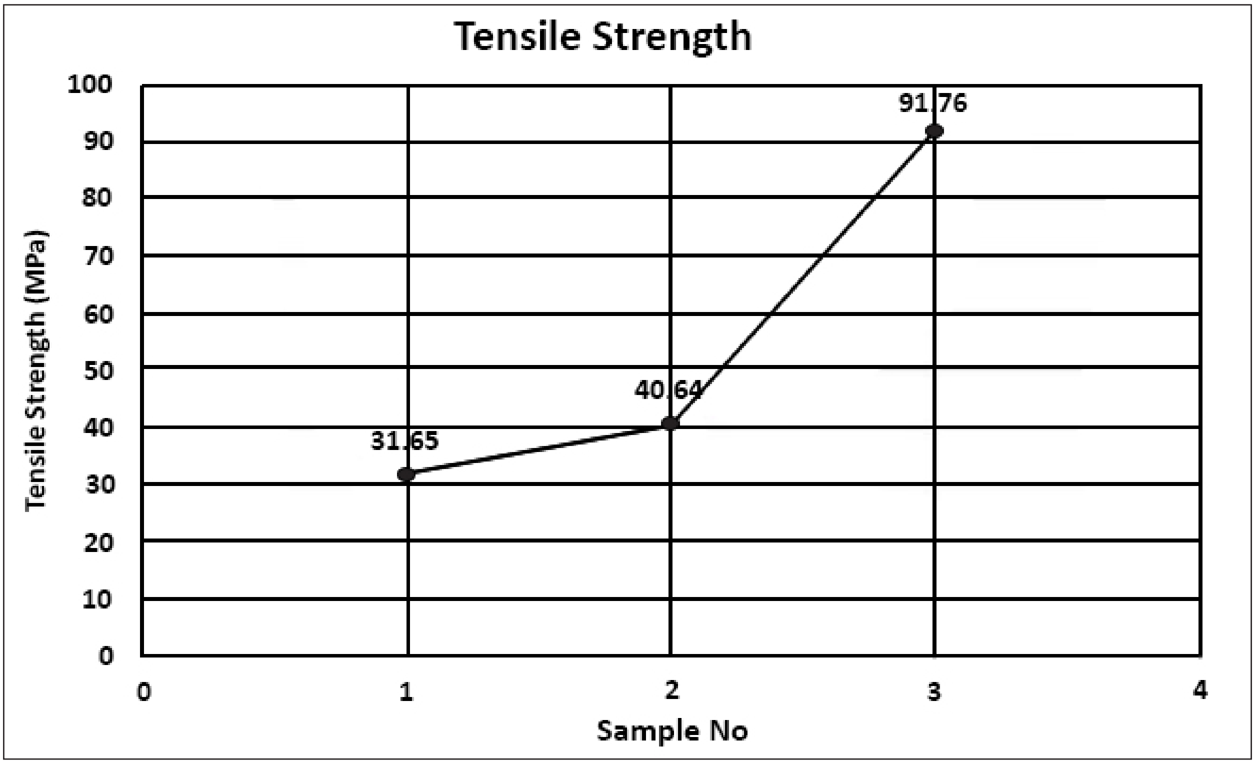


Fig. 4.3. Tensile strength.

Table 4.2
Compression strength test results of AMMC composites.

Sample No	Composition	Compression strength (KN)
1	AL 7475(97%) +TiC (3%)	58.16
2	AL 7475(97%) +TiC (1.5%) +WC (1.5%)	63.07
3	AL 7475(97%) +TiC (1%) +WC (1%) +BN (1%)	58.87

Table 4.3
Hardness test results of AMMC composites.

Sample No	Composition	Reading1 (BHN)	Reading2 (BHN)	Reading3 (BHN)	Average (BHN)
1.	AL 7475(97%) +TiC (3%)	54	53	54	53.6
2.	AL 7475(97%) +TiC (1.5%) +WC (1.5%)	74	72	70	72
3.	AL 7475(97%) +TiC (1%) +WC (1%) +BN (1%)	106	104	102	104

4.3. Compression strength

To know the compressive strength of material, compressive test was conducted on UTM. The Compressive Strength of the materials was varied on different compositions. The Three Specimens has different Compressive strength as shown in the below Table 4.2.

4.4. Hardness test

The specimens have been tested for hardness using Brinell hardness test, average of three readings is taken for each specimen. The hardness test results show that Al7475/ TiC/WC/BN hybrid micro-composites exhibited higher hardness results than the aluminium alloy. The presence of the reinforcements (TiC/WC/BN) in the

Table 4.4
Electrical conductivity test results of AMMC composites.

Sample No	Composition	Electrical Conductivity (S m^{-1})
1.	AL 7475(97%) +TiC (3%)	44.64
2.	AL 7475(97%) +TiC (1.5%) +WC (1.5%)	48.7
3.	AL 7475(97%) +TiC (1%) +WC (1%) +BN (1%)	53.57

Fig. 4.4. Universal testing machine.

Fig. 4.5. Tested specimens.

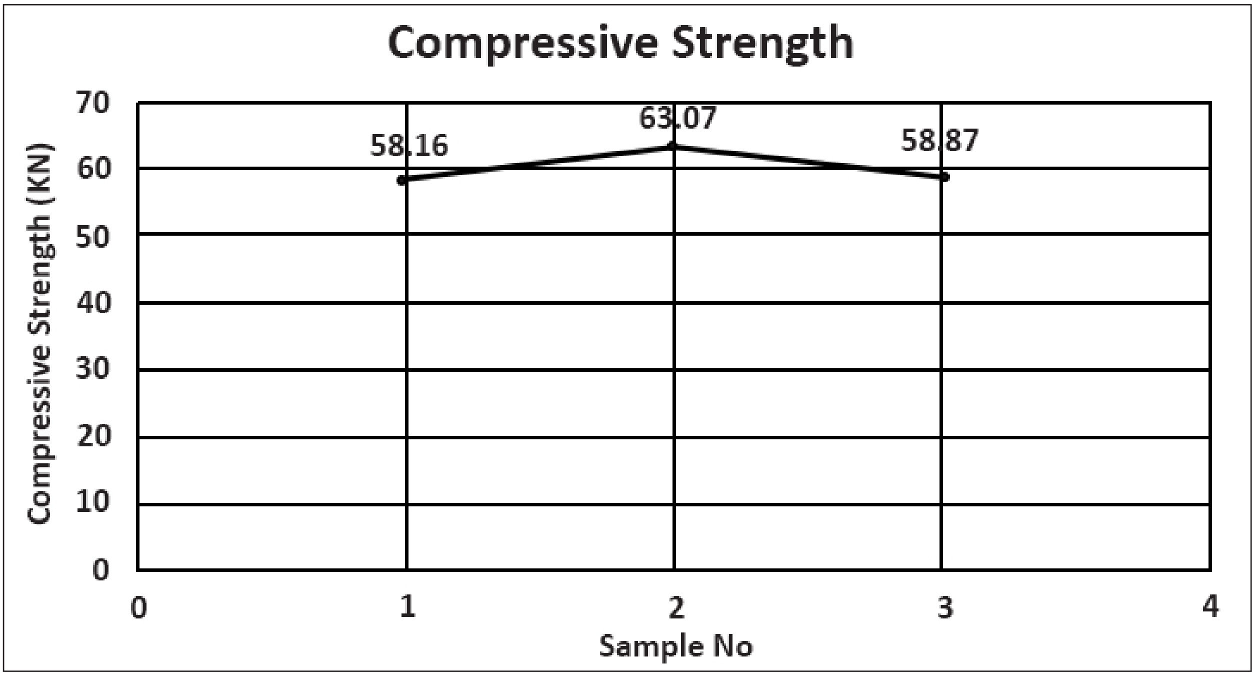


Fig. 4.6. Compression strength.

aluminium matrix offers more resistance to plastic deformation of the hybrid Nano composites. Table 4.4 shows the hardness test values of the respective samples.

Fig. 4.7. Hardness testing machine.

4.5. Electrical conductivity

The electrical conductivity of a material is a number describing how much voltage is required to get an amount of electric current to flow. If electricity can flow easily through a material, that material has low resistivity. If electricity has great difficulty flowing through a material has high resistivity. In this work, to two-point technique is used to measure the resistivity. The resistivity of the material can be obtained by measuring the resistance and physical dimensions of a bar of material, as shown in fig. In this case, the material is cut into the shape of a rectangular bar of length l, height h, and width w, copper wires are attached to both ends of the bar, called two-point technique where wires are

Fig. 4.8. Tested specimens.

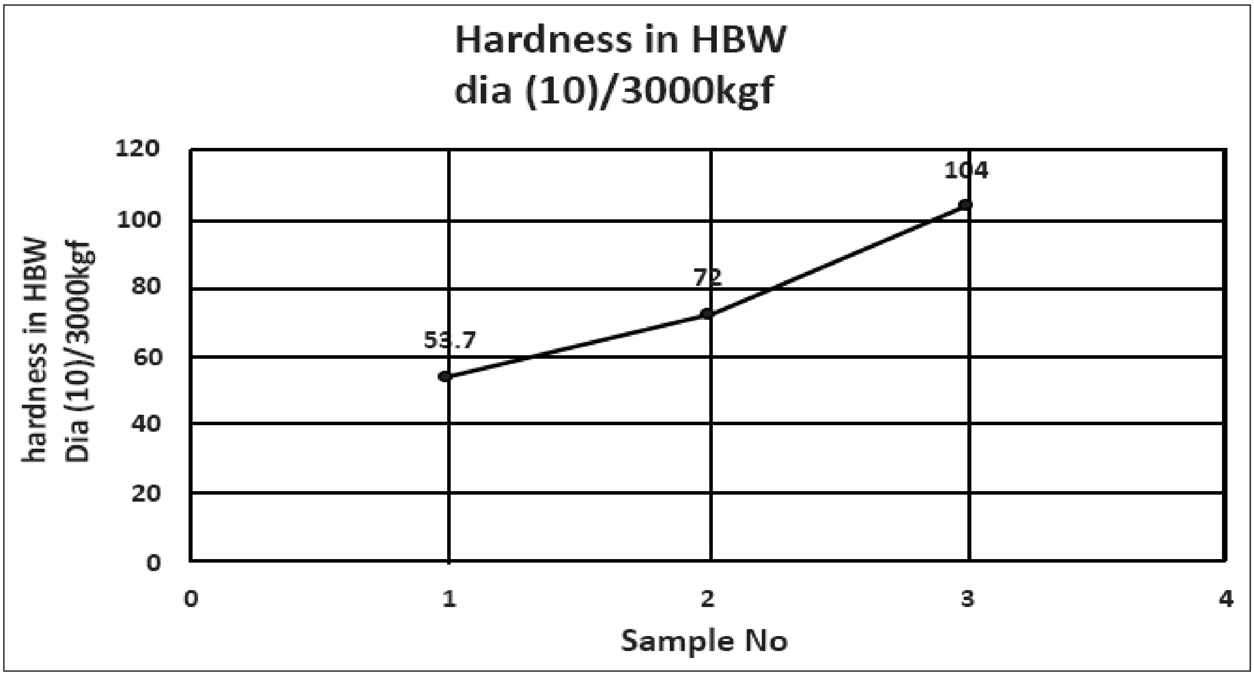


Fig. 4.9. Hardness.

attached to the material at two points. A voltage source applies a voltage V across the bar, causing a current I to flow through the bar. The amount of resistance R that flows through the bar is measured by the multimeter, which is connected in series with the bar and voltage source. The voltage drop across the ammeter should be negligible. The results are tabulated in the following Table 4.4.

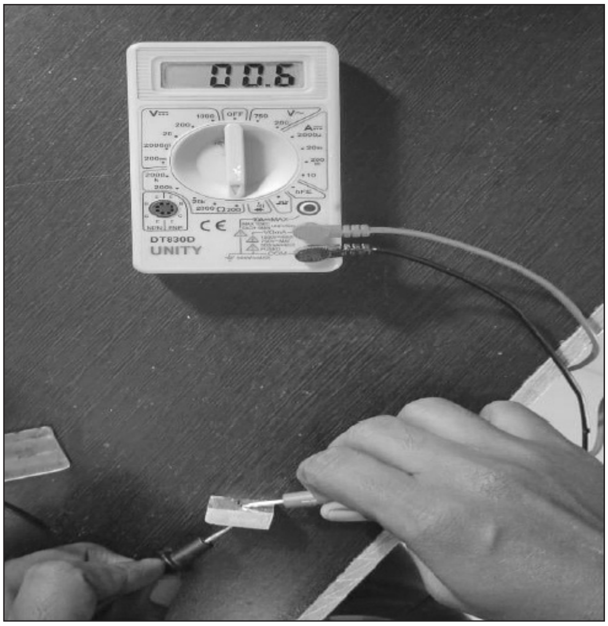


Fig. 4.10. Multimeter.

5. Optimization of WEDM Process Parameters

5.1. Introduction

Based on mechanical properties conclude that out of three compositions A, B, C composition 'C' gives better values of mechanical properties such as tensile strength, compression strength etc. To know the machining behavior of composite material under wire electrical discharge machining process parameters such as Pulse on, Pulse off, input current and wire feed and the output responses such as material removal rate and kerf width. To optimize the output responses by using input process parameters to determine the best sequence of input process parameters using GRAY relational analysis and to know the most influencing parameter among input parameters by using Analysis of variance.

In design of experiments are used to apply the WEDM process parameters such that pulse on, pulse off, input current and wire feed as input parameters and cutting time, material removal rate and kerf width are being done by the Wire Electrical Discharge Machining (WEDM) experimental set-up which is connected to a monitor through CPU. Different parameters which are measured as mentioned below,

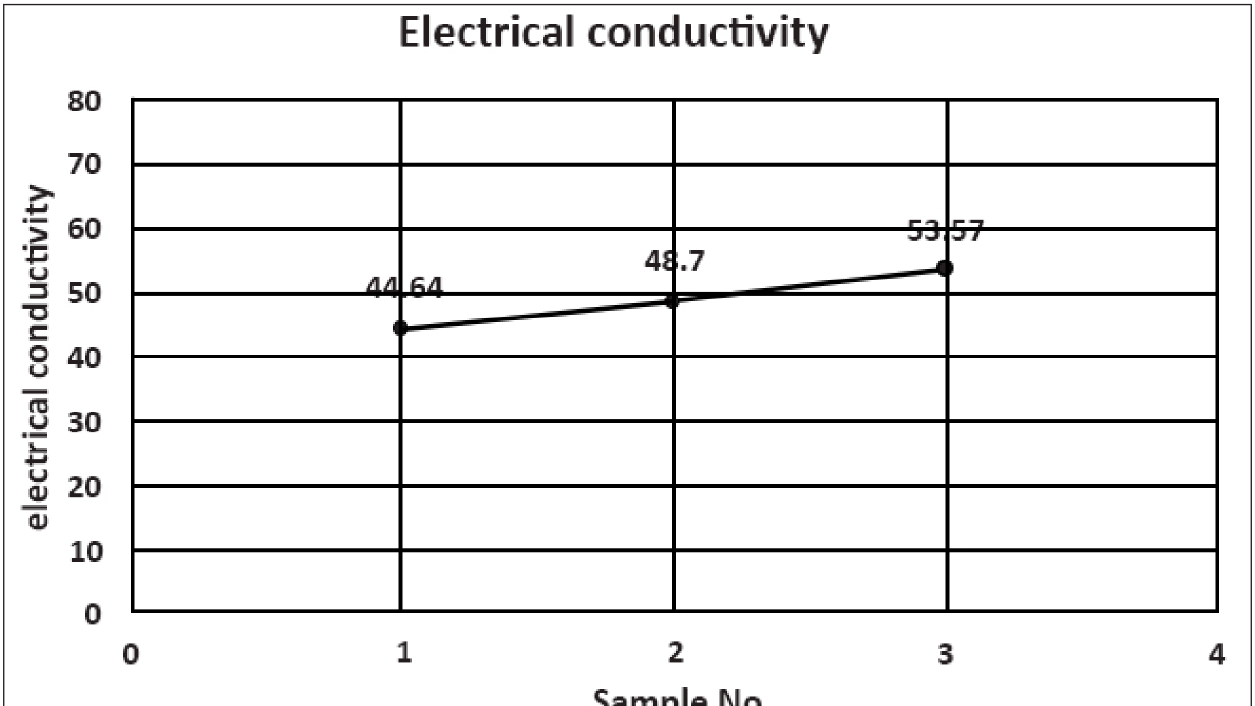


Fig. 4.11. Electrical conductivity.

Input factors: Pulse on time (T_{on}), pulse off time (T_{off}), input current (i/c), wire feed (wf)

Output responses: Material removal rate (MRR), Kerf width (mm).

5.2. Machining responses

Table 5.1
Machining responses for corresponding inputs.

S.no	Input factors				Output responses		
	Pulse on (Ton)	Pulse off (Toff)	Input current (I/c)	Wire feed (Wf)	Cutting time (min)	MRR (mm^3/min)	Kerf width(mm)
1	90	20	1	20	88	13.52	0.175
2	90	25	2	25	72	16.52	0.445
3	90	30	3	30	82	14.51	0.305
4	95	20	2	30	78	15.25	0.475
5	95	25	3	20	96	12.39	0.450
6	95	30	1	25	52	22.88	0.175
7	100	20	3	25	75	15.86	0.380
8	100	25	1	30	62	19.19	0.190
9	100	30	2	20	100	11.90	0.150

The S/N ratios given in the table and the average value of material removal rate for each process parameter and the respective levels are plotted in the graph (Fig.5.2). The main effect plot shows the influence of each parameter on machining performance.

5.3. Material removal rate

The amount of volume of material (work piece material) is removed in one minute of time is called material removal rate. Material removal rate is calculated by mathematically using formula,

MRR = V/Tmm^3/min,

Where v is the volume of material removed from the work piece and t is the time taken to complete the machining process.

The slots were shown in the fig 5.1 being done by the wire electrical discharge machining process during machining of the work piece.

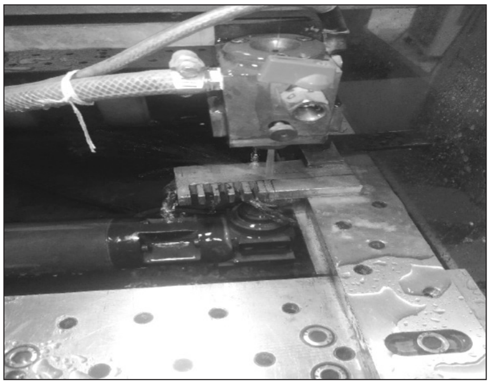


Fig. 5.1. Machining of work piece.

MRR values recorded in the Table 5.1. The tabulated results below (Table 5.2) depict the process parameter, performance parameter and the SN ration is done by Taguchi. SN ratio signifies the higher value representing better performance such as Material removal rate 'higher-the-better'. By doing the Taguchi to the calculated MRR values to find the signal to noise ratio, the S/N ratio values are tabulated shown in Table 5.2.

The graph represents the mean of signal to noise ratios of material removal rate to the corresponding process parameters. Material Removal rate is clearly increased while machining with the pulse on 95, pulse off 30, input current 1 amp and wire feed of 25.

5.4. Kerf width (mm)

Kerf width is measured in millimeters (mm). It is the measure of the amount of the material that is wasted during machining and determining the dimensional accuracy of the finished part.

Table 5.2
S/N ratios of MRR to the corresponding process parameters and levels.

S.no	Pulse On (sec)	Pulse off (sec)	Input current (amp)	wire feed (m/min)	Material removal rate (mm^3/min)	S/N Ratio
1	90	20	1	20	13.52	22.6195
2	90	25	2	25	16.52	24.3602
3	90	30	3	30	14.51	23.2333
4	95	20	2	30	15.25	23.6654
5	95	25	3	20	12.39	21.8614
6	95	30	1	25	22.88	27.1891
7	100	20	3	25	15.86	24.0061
8	100	25	1	30	19.19	25.6615
9	100	30	2	20	11.90	21.5109

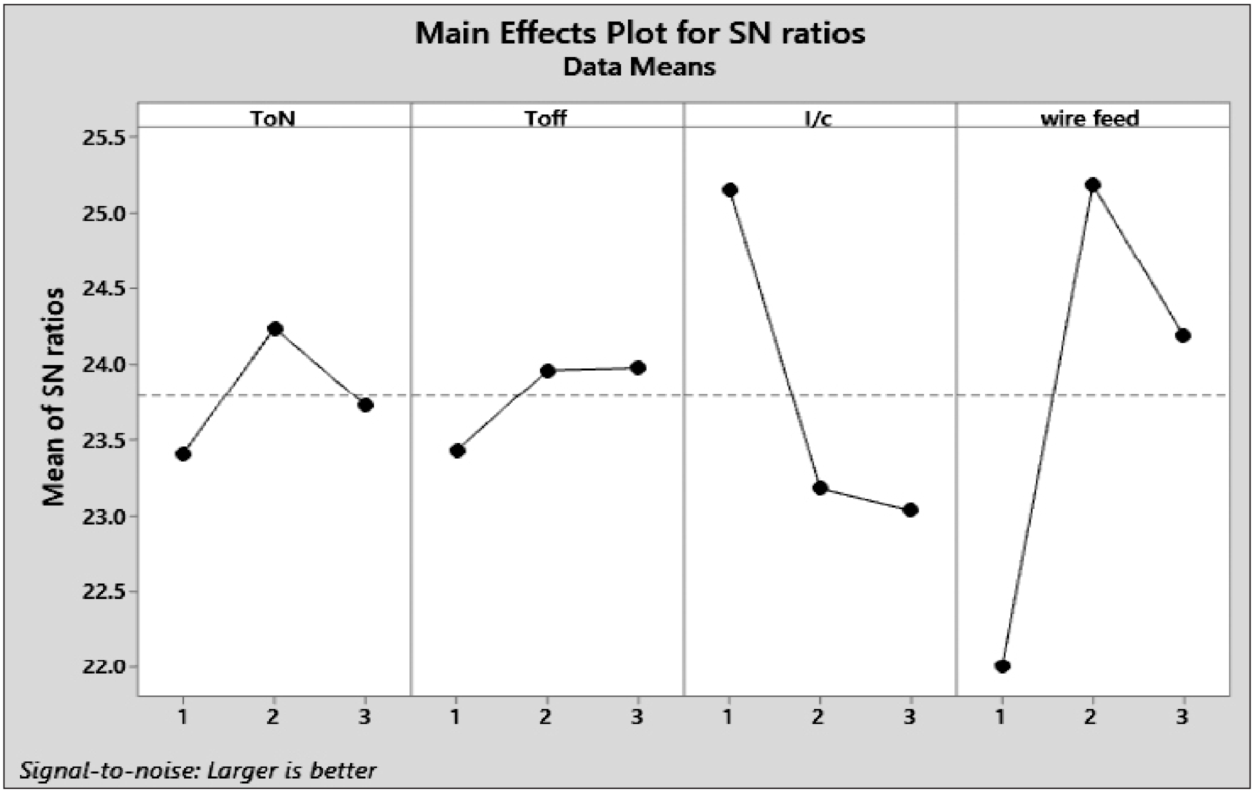


Fig. 5.2. Mean of signal-to-noise ratio of MRR v/s process parameters.

Table 5.3
Upper and lower notches of kerf width.

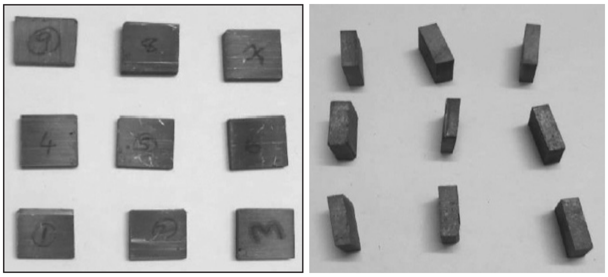
upper notch (mm)	5.10	5.24	5.28	5.61	5.08	4.83	4.39	6.25	5.04
Lower notch (mm)	4.75	5.65	5.33	5.34	4.18	4.82	4.37	6.09	5.26

Kerf width is measured using digital Vernier caliper by taking the difference between in width assumed and width obtained.

Assumed width =5mm, Obtained width in the table as follows.

Kerf width = |Assumed width- (average of upper and lower notches)| = 0.175

The tabulated results below (Table 5.3) depict the process parameter, performance parameter and



(a) (b)

Fig. 5.3. (a) and (b) are the removed pieces from work piece by WEDM process.

Table 5.4

S/N ratios of KERF WIDTH to the corresponding process parameters and levels.

S.no	Pulse On (sec)	Pulse off (sec)	Input current (amp)	wire feed (m/min)	kerf width (mm)	S/N ratio
1	90	20	1	20	0.445	7.0328
2	90	25	2	25	0.305	10.3140
3	90	30	3	30	0.475	6.4661
4	95	20	2	30	0.450	6.9357
5	95	25	3	20	0.175	15.1392
6	95	30	1	25	0.380	8.4043
7	100	20	3	25	0.190	14.4249
8	100	25	1	30	0.150	16.4782
9	100	30	2	20	0.445	7.0328

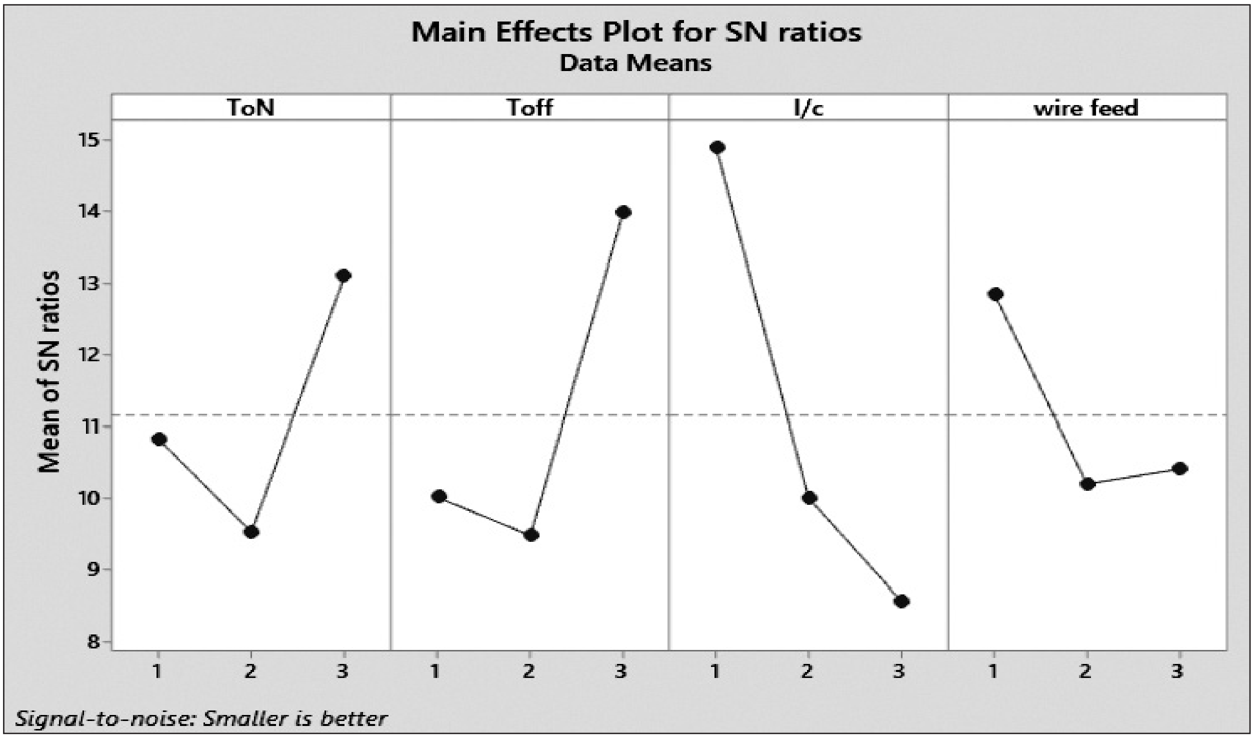


Fig. 5.4. Mean of signal-to-noise ratio of kerf width v/s process parameters.

the S/N ratio is done by Taguchi. SN ratio signifies the lesser value representing better performance such as kerf width 'smaller-the-better'. By doing the Taguchi to the calculated Kerf width values to find the signal to noise ratio, the S/N ratio values are tabulated below,

The SN ratios given in the table and the average value of Kerf width for each process parameter and the respective levels are plotted in the graph (Fig.5.4). The main effect plot shows the influence of each parameter on machining performance.

The graph represents the mean of signal to noise ratios of Kerf width to the corresponding process parameters. Kerf width is clearly decreasing while machining with the pulse on 100, pulse off 25, input current 1 amp and wire feed of 30.

5.5. Implementing the grey relational analysis technique to the experimental value

By applying the Grey relational analysis, following are the obtained results to the respective experiments,

Thus the grey relational grade is found out and the ranking was given according to the highest value of mean grey relational grade which implies stronger correlation and better performance taken from the Taguchi analysis

Table 5.5
Normalization values of process parameters.

S.No	Pulse On (sec)	Pulse off (sec)	Input current (amp)	wire feed (m/min)	MRR (mm^3/min)	Kerf Width (mm)	Normalized values	
							MRR (mm^3/min)	Kerf width (mm)
1	90	20	1	20	13.52	0.175	0.147541	0.923077
2	90	25	2	25	16.52	0.445	0.420765	0.092308
3	90	30	3	30	14.51	0.305	0.237705	0.523077
4	95	20	2	30	15.25	0.475	0.3051	0
5	95	25	3	20	12.39	0.450	0.044627	0.076923
6	95	30	1	25	22.88	0.175	1	0.923077
7	100	20	3	25	15.86	0.380	0.360656	0.292308
8	100	25	1	30	19.19	0.190	0.663934	0.876923
9	100	30	2	20	11.90	0.150	0	1

Table 5.6
Deviation sequence values for the process parameters.

S.no	Pulse On (µs)	Pulse off (µs)	Input current (amps)	wire feed (m/min)	MRR (mm^3/ min)	Kerf Width (mm)	Deviation sequence	
							MRR (mm^3/min)	Kerf Width (mm)
1	90	20	1	20	13.52	0.175	0.852459	0.076923
2	90	25	2	25	16.52	0.445	0.579235	0.907692
3	90	30	3	30	14.51	0.305	0.762295	0.476923
4	95	20	2	30	15.25	0.475	0.6949	1
5	95	25	3	20	12.39	0.450	0.955373	0.923077
6	95	30	1	25	22.88	0.175	0	0.076923
7	100	20	3	25	15.86	0.380	0.639344	0.707692
8	100	25	1	30	19.19	0.190	0.336066	0.123077
9	100	30	2	20	11.90	0.150	1	0

Table 5.7
Grey relation coefficient and grey relation grade to the corresponding experiments.

S.No	Input parameters				Gray relation coefficient		Grey relation grade (GRG)	Rank
	Pulse on time(sec)	Pulse off time (sec)	Input Current (amp)	Wire feed (m/min)	MRR (mm^3/min)	Kerf Width (mm)		
1	90	20	1	20	0.369697	0.866667	0.618182	4
2	90	25	2	25	0.463291	0.355191	0.409241	7
3	90	30	3	30	0.396104	0.511811	0.453957	5
4	95	20	2	30	0.418445	0.333333	0.375889	8
5	95	25	3	20	0.343554	0.351351	0.347453	9
6	95	30	1	25	1	0.866667	0.933333	1
7	100	20	3	25	0.438849	0.414013	0.426431	6
8	100	25	1	30	0.598039	0.802469	0.700254	2
9	100	30	2	20	0.333333	1	0.666667	3

Table 5.8
GRG values for each parameter at each level.

Level	Pulse on time (ToN)	Pulse off time (Toff)	Input current (I/c)	wire feed (wf)
1	-6.266	-6.693	**-2.624**	-5.627
2	-6.093	-6.679	-6.594	**-5.254**
3	**-4.673**	**-3.660**	-7.815	-6.151
(Max-min)=Delta	1.593	3.033	5.191	0.897
RANK	3	2	1	4

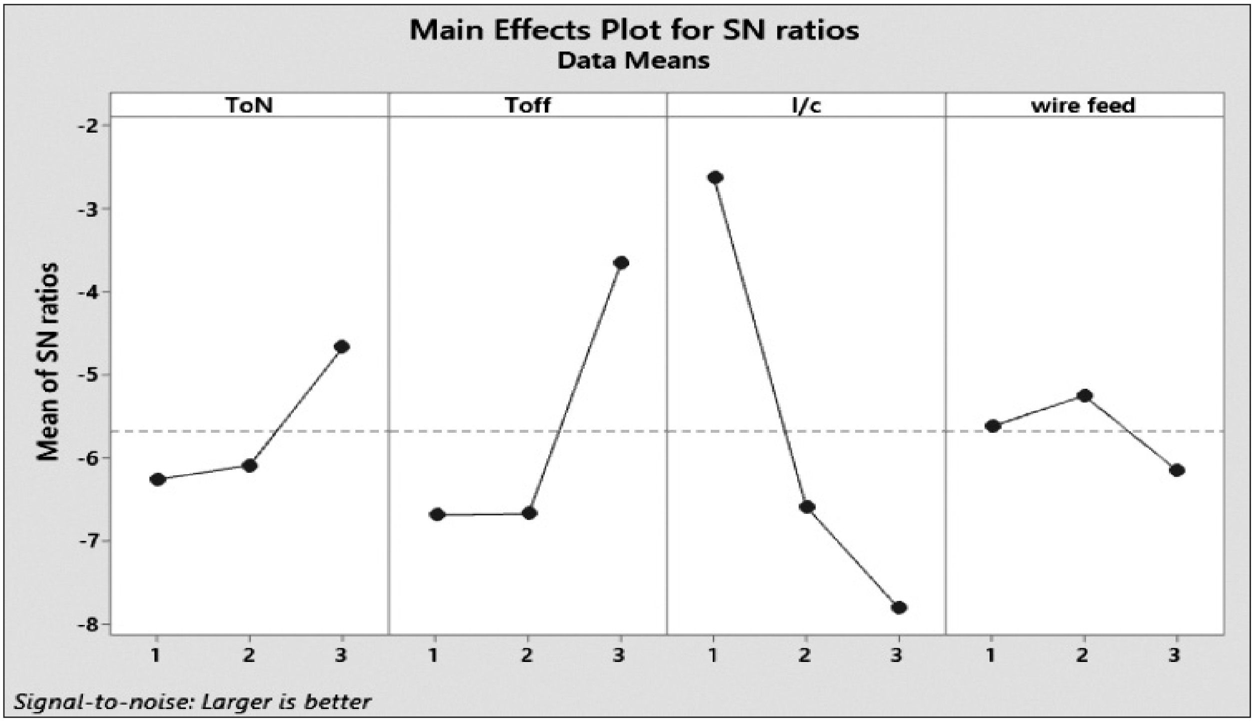


Fig. 5.5. S/N ratios to the grey relational grade Vs input parameters.

Table 5.9
Results of ANOVA on GREY relational grade (GRG).

Source	DF	Adj SS	Contribution (%)	Adj MS
ToN	2	0.016304	5.37	0.008152
Toff	2	0.084335	27.797	0.042167
I/c	2	0.193171	63.67	0.096586
wire feed	2	0.009579	3.1573	0.004789
Error	0	*	*	*
Total	8	0.303389	100.00%	

as shown in above table the optimal values are selected from the mean table will be the higher grade that indicates the lower parameters. Thus the optimal settings are determined such as (pulse on-100, pulse off- 30, input current-1 amp, and Wire feed-25) that implies Input current -1 amp is most influencing parameter out of all 3 parameters. Next analysis of variance (ANOVA) is formulated using Grey relational grade values and to show the significance of the parameters as shown in table below and the most significant parameter here input current with 63.67% contribution.

The discussion has been done on the results in this chapter by the analysis of Taguchi design and Grey relational grade to know the performances individually,

❖ The material removal rate is maximum at the combination of parameters such as pulse on-95µs, pulse off-30µs, input current-1 amp and wire feed-25.

❖ The KERF width is minimum at the combination of parameters such as pulse on-100µs, pulse off - 25µs, input current-1 amp and wire feed-30.

6. Conclusions

It is observed from the results of the following conclusions were drawn.

- Stir casting process is employed for manufacture of Al7475-BN / TiC / WC composites. By varying wt% of reinforcements of 3% wt of BN/ TiC/WC. It is found that by the addition of boron nitride and tungsten carbide increases the hardness.
- The hardness of Aluminium alloy increases from 53.6 BHN to 104 BHN due to the addition of Boron nitride and Tungsten carbide. It was observed that tensile strength increased by adding the boron nitride, tungsten carbide and titanium carbide.
- It was found that the compression strength of the composites, initially increases from 58.16 to 58.83MPa with the addition of Titanium carbide (TiC) and tungsten carbide (WC) it is also observed by adding Boron Nitride the compression strength is decreased.
- It is found that the electrical conductivity of the material Al 7475 (97%) - TiC (1%) /WC (1%) /BN (1%) is better than other sample compositions.
- In WEDM process MRR and Kerf width are optimized by using Taguchi process parameters for MRR: pulse on 95, pulse off 30, input current 1 amp and wire feed of 25 and for kerf width: pulse on 100, pulse off 25, input current 1 amp and wire feed of 30.
- The optimum process parameters were evaluated by using gray relational analysis are pulse on-100, pulse off - 30, input current-1 amp, and Wire feed-25 that implies Input current -1 amp is most influencing parameter out of all four process parameters.
- By applying Analysis of variance (ANOVA) to Grey relational grade values and it is identified that input current is 63.67% significant contribution.

Scope For Future Work

This work may be extended for base materials like polymers and ceramics with addition of reinforcements like carbon nano tubes, silicon carbide etc.

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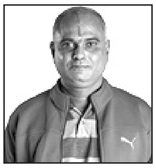

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