



OPTIMIZATION OF SIGNIFICANT PARAMETER ON MECHANICAL ACTIVITIES OF ALMG1SICU FUSION METAL MATRIX COMPOSITES WITH TAGUCHI INCLUDED FUZZY APPROACH

A.Seshappa, B.Venkatesh and T.Vijaybabu

Department of Mechanical Engineering, Vardhaman College of Engineering,
Shamshabad, Hyderabad, India

P.Prasanna

Department of Mechanical Engineering, JNTU College of Engineering,
Hyderabad, India

ABSTRACT

Al alloy material initiate to the preeminent substitute among its inimitable capability of conniving the materials to award essential properties. Metal Matrix Composites of Al alloy (AMMCs) are in advancing extensive widen approval for automobile, industrial, and aerospace applications for the reason that of their squat density, elevated strength and high-quality structural rigidity. In this research work, a challenge is prepared to scrutinize the end product of significant parameters such as nature of corroboration, size of the reinforcing constituent part and weight proportion on motorized properties. Stir casting procedure has been in employment to put in order the composites. The rejoinder parameters were tensile strength, impact strength and density. The design of experiments (DOE) come close to with taguchi technique was engaged to explore the motorized activities of fusion composites. Fuzzy approaches were used to explore the most favorable blend of influencing parameters on the motorized activities.

Keywords: Hybrid MMCs, DOE, Taguchi and Fuzzy logic

Cite this Article: A.Seshappa, B.Venkatesh, T.Vijaybabu and P.Prasanna, Optimization of significant parameter on Mechanical activities of AlMg1SiCu Fusion Metal Matrix Composites with Taguchi included Fuzzy Approach, International Journal of Mechanical Engineering and Technology 8(12), 2017, pp. 1089–1095
<http://www.iaeme.com/IJMET/issues.asp?JType=IJMET&VType=8&IType=12>

1. INTRODUCTION:

Conservative monumental resources have restrictions in achieve good permutation of strong point, rigidity, sturdiness along with density. To triumph over these inadequacy with to congregate the eternally growing insist of current day expertise, composites are for the most part gifted materials of topical attention, individual of these mortal fusion Metal Matrix Composites (FMMCs) which acquire elevated precise strong point, sturdiness, impact strength as well as squat kindliness to high temperature vary. While an effect, several in progress relevance for FMMCs be in aerospace and automobile machineries somewhere the overhaul upbringing are challenging along with active consignments is universal [1].FMMCs characteristically finished of broken string or constituent element segment that is rigid and stronger than the incessant matrix segment.

Aluminum based Metal Matrix Composites are silent the subject matter of passionate learning, as their squat density present further reward in a number of relevance. Amongst a variety of functional aluminum alloys, aluminum alloy AlMg1 SiCu (Al6061) is naturally characterized by properties such as fluidity, cast ability, deterioration conflict and elevated strength -influence proportion. This metals contains universally used as a pedestal metals on behalf of MMCs toughened among array of fibers, constituent part also whiskers [2]. Within modern existence, significant effort contain finished on Silicon carbide (SiC) toughened metal matrix composites, since MMC gives elevated strength, along with graphite toughened metal matrix composites shown evidence of squat density, squat wear rate and admirable ant seizing properties. Motorized properties of MMCs are precious by the dimension, profile and influence whole of the strengthening, matrix material and response at the crossing point [3].

2. LITERATURE REVIEW:

K.L.meena, et.al [4] investigated their work on Al/SiC Metal matrix composites with Al 6063 as matrix and SiC as reinforcement of various sizes i.e,74 μ , 53 μ ,44 μ by the melt stirring technique, and reported that the mechanical properties were increased by decreasing the particle size and increasing the weight fraction of reinforcement. Khalid Mahmood Ghauri et.al [5] investigated their work on motorized properties of Aluminium ,Silicon carbide Metal matrix composites among Al-6061 as matrix and Silicon Carbide as strengthening of 10 μ by changeable the weight fraction of the composites, and reported that the mechanical properties were increased by increasing the weight fraction of reinforcement. Prashant.S et.al [6] investigated their work on motorized properties of Aluminium, Graphite Metal matrix composites among Al-6061 as matrix and Graphite as reinforcement by varying the weight fraction of the composites, and reported that the tensile strength increases high upto 9% and increases very slightly more than 9%, because of excess of graphite. S. Dhanalakshmi et.al investigated their work on processing parameters of AlSiC MMC produced by stir casting [7]. Vijaya Kumar and Venkataramaiah [8] have developed a fusion come close to combine Taguchi, grey relational analysis technique also fuzzy reason on the way to bring in their improvement in make a hole by drilling practice.

Fuzzy reason: Fuzzy reasons have grand competence to imprison person valid way of thinking, managerial and other aspects of person cognition. It overcomes the precincts of traditional valid systems, which impress inbuilt precincts on illustration of inaccurate concepts. Ambiguity the coefficients and constraints may be as expected modeled by fuzzy reason. Modelings by fuzzy reason opens awake an innovative manner to optimize critical circumstances and in addition apparatus choice significance of combination among fuzzy and Artificial Neural Network (ANN) -based method for valuable course of action direct the built-up methods. Quite a lot of applications of fuzzy situate presumption-based modeling of metal spiteful processes are reported in the prose. Hashmi, et al [9] functional fuzzy situate

presumption reason for choice of spiteful circumstances in machining. Lee, et al[10] use fuzzy situate presumption -based non -linear model for a spinning progression as a further effective apparatus than predictable statistical modeling techniques if there exists ‘fuzziness’ in the progression be in command of variables.

3. EXPERIMENTATION:

3.1. Materials and preparation:

The Composite material for current learning is AlMg1 SiCu alloy. The reinforcing material selected was silicon carbide (SiC) element and graphite (Gr) of size 4, 20 and 38 μm . In this method, first the Al-6061 be positioned in an electrical conflict heating system and passionate to beyond its liquids temperature i.e. 800°c , so that the Al-6061 is thoroughly melted. This thaw out is followed by chilled along en route for a high temperature involving the liquors as well as solidus positions with reserved back in a partly solid position. Proceeding to constituent part adding together, Magnesium fine particles was further to melt to sustain the Wetability. Next to this phase, the preheated particles are further in three stepladder into the dissolve and miscellaneous with the facilitate of stirrer for 10 mins, and the dissolve was poured into the significance die at a temperature range of $750^{\circ} - 800^{\circ}\text{c}$.

3.2. Testing of composites:

The tensile behaviour of all the primed samples pieces was strong-minded as per ASTM B-557 M “Standard Test Methods of Tension Testing produced and emit AlMg1 SiC-Alloy Products”. The Impact strength of the composites were approved out on charpy impact tester as per ASTM E23-02a “Standard Test Methods for Notched Bar Impact Testing of Metallic Materials” .The densities of all the primed samples were investigated experimentally by the “Archimedean’s principle”.

Mechanical Properties tests have been performed on prepared composites by considering different parameter combinations. Tensile strength, Impact strength and Density are selected as indices to evaluate the mechanical properties of the MMC. Therefore these are considered as response characteristics in this study. Basically tensile strength and impact strength should be maximized and Density should be minimized for any MMC for better performance.

In the present work, three influential parameters be measured and every parameter is position at three stages. The considerations with its stages are made known here Table-1. For bursting reasons blueprint, the tentative runs mandatory are (levels)^{factors} equal to $3^3 = 27$. To play down the investigational cost, unfinished factorial blueprint is preferred, ie. $3^{3-1} = 9$ runs. Therefore Taguchi investigational blueprint L9 is preferred for carry out experimentation (Table --2). Conduct test are execute according to this blueprint also the ethics of Tensile strength, Impact strength and Density are recorded (Table-2) for each one investigational run.

Table 1 Influential parameters at three stages

Parameters Design	Process Parameters		
	S1	S2	S3
Type of reinforcement	Silica Carbide (SiC)	Graphite(Gr)	SiC/Graphite
Size of particle (μm)	4	20	38
Weight Percentage (%)	5	10	15

4. OPTIMIZATION OF MACHINING PARAMETERS:

The responses Tensile strength, Impact strength and Density are analyzed using fuzzy tool box of Mat lab software and overall fuzzy ranking ethics are strong-minded. The best possible stages of significant parameters are resolute taking place overall fuzzy ranking as follows:

Achievement of Fuzzy reason: Fuzzy reasons take action a fuzzy interfering prime mover with a Fuzzification defuzzification unit. Fuzzification state the key in changeable in the variety of fuzzy association standards based on a variety of association functions. leading regulations in linguistic variety, for example if spiteful power is elevated and machining moment in time is elevated, then apparatus wear is elevated, be formulated on the beginning of investigational interpretation. Based on each one regulation, presumption can be strained on yield ranking and association assessment. Inferences obtained as of a variety of regulations are mutual to pull in at a ultimate conclusion. The association principles thus obtained is defuzzified using a variety of techniques to attain accurate assessment.

Table 2 Experimental design and Data

Exp. Run No.	Input			Responses		
	Type of reinforcement	Size (μ)	Wt. (%)	Tensile strength (Mpa)	Impact strength (Joules)	Density (gm/cc)
1	SiC	4	5	168.24	27	2.87
2	SiC	20	10	159.83	28	2.95
3	SiC	38	15	152.95	31	2.94
4	Graphite	4	10	148.61	22	2.68
5	Graphite	20	15	149.75	20	2.74
6	Graphite	38	5	148.26	17	2.76
7	SiC/Graphite	4	15	196.45	45	2.69
8	SiC/Graphite	20	5	188.32	28	2.72
9	SiC/Graphite	38	10	182.23	31	2.71

4.1. Purpose of Largely Fuzzy Position:

A fuzzy reason element involves a fuzzifier, association purpose, a fuzzy regulation pedestal, a presumption prime mover along with a defuzzifier. This fuzzy reason investigation, the fuzzifier apply association occupation to fuzzify the grey next of kin co-efficient primary. After that, the presumption engine achieves a fuzzy way of thinking on fuzzy regulations in the direction of engender a fuzzy assessment. To end with, the defuzzifier exchanges the fuzzy assessment interested in a fuzzy position. The constitution build for this lesson is a three participation one is yield fuzzy reason element as is evidence for in Fig.1. The utility of the fuzzifier is to translate external snappish situate of participation statistics keen on suitable linguistic fuzzy position of in sequence.

The enter changeable of the fuzzy reason method in the present learning are Tensile strength, Impact strength and Density. As reported in Fig-2 the behavior analysis implemented through linguistic fuzzy subsets as association functions of triangle form, are homogeneously dispense keen on three fuzzy sub-sets are Low (L), Middling (M), along with High (H) position. The fuzzy regulation a pedestal consists of a cluster if-then manages

regulations in the direction of convey the presumption association among key in and yield. A representative linguistic fuzzy regulation term Mamdani is illustrate as

Tenet 1: if x_1 is A_1 , x_2 is B_1 subsequently y is E_1 else Tenet 2: if x_1 is A_2 , x_2 is B_2 , subsequently y is E_2 else

Tenet n: if x_1 is A_n , x_2 is B_n , subsequently y is E_n else

In above A_1 , B_1 be fuzzy sub-sets characterize via the equivalent association occupations i.e., $\alpha/4A_1$, $\alpha/4B_1$. The yield changeable are the Fuzzy ranking y_0 , as well as rehabilitated keen on linguistic fuzzy sub-sets using association occupations of a triangle appearance, as be evidence for in Fig. 3.

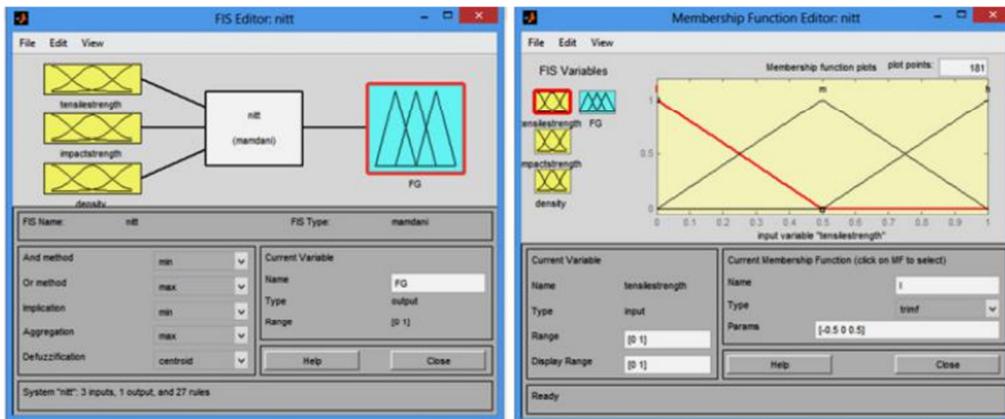


Figure 1 Three input also one yield fuzzy logic unit Figure 2 Input parameters for fuzzy

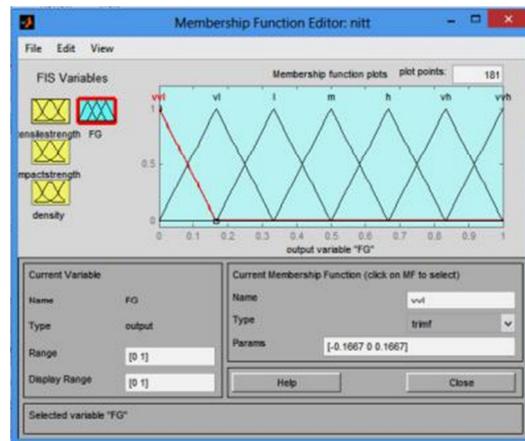


Figure 3 Membership (Association) purposes in favor of exit values

Different the key in changeable, the yield changeable is consigned on comparatively 9 sub-sets i.e., very very low (VVL), very low (VL), low (L) Medium low (ML) medium low, medium (M), medium high (MH) high (H), very high (VH), very very high (VVH) Then, taking into consideration the traditional values of three presentation distinctiveness for key is changeable, nine fuzzy regulation be describe. The fuzzy presumption prime mover are root of a fuzzy organization. It be able to answer a problem by imitates the accepted wisdom also choice blueprint of person living being by means of fairly accurate or fuzzy way of thinking. In this document, the maxim compositional procedure of Mamdani is accepted to complete estimate of fuzzy way of thinking.

4.2. Best Possible Levels of Machining Parameters

Once formative the taken as a whole fuzzy ranking principle as listed in Table-3, the outcome of each one process parameter is divided based on taken as a whole Fuzzy ranking at different levels. Fundamentally, huge Fuzzy ranking earnings are seal in the direction of the manufactured goods worth, thus, an elevated charge of the Fuzzy ranking is enviable. Beginning the table-4, it shows that the experiment run 7 has highest fuzzy ranking i.e, 0.9153 and it indicates the optimal process parameters with the best level are type of reinforcement is SiC/Gr (hybid) at S1 - 3, size 4μ at S1-1 and weight percentage 15% at S1- 3. The most favorable S1 meant for the convenient restriction attain beginning this method are established by the conformation investigation be evidence for in Table-4.

Table 3 Overall fuzzy ranking

Exp. Run	Overall fuzzy ranking
1	0.2714
2	0.2908
3	0.301
4	0.4088
5	0.2832
6	0.2067
7	0.9153
8	0.6339
9	0.6642

Table 4 Conformation test results

Type of reinforcement	Size (μ)	Wt. (%)	Tensile strength (Mpa)	Impact strength (Joules)	Density (gm/cc)
3	4	15	196.35	45	2.69

5. CONCLUSIONS:

The experiments have been conducted on various levels and parameters and obtained information has been analyzed using Fuzzy reason. The authority type of reinforcement, size and weight percentage of the particle on mechanical behaviour of composites was studied. Optimum influencing parameter combination has been found at the size of 4μ , combined SiC/Graphite of 15 % using fuzzy reason method which yields good outcome within high strength and low density.

REFERENCE

- [1] C. J. Tong, M. R. Chen, S. K. Chen, J. W. Yeh, T. T. Shun, S. J. Lin and S. Y. Chang: Mechanical performance of the AlxCoCrCuFeNi high-entropy alloy system with multi principal elements Metallurgical and Materials Transactions A May 2005, Volume 36, Issue 5, pp 1263–1271.
- [2] M.K. Surappa: Aluminium matrix composites: Challenges and opportunities, Sadhana, Vol. 28, No. 1&2, pp. 319–334, 2003.
- [3] Journals of material engineering and performance, springer, Dec 2011, vol 20, issue 9.
- [4] K.L. Meena, Dr. A. Manna, Dr. S.S. Banwait and Dr. Jaswanti An Analysis of Mechanical Properties of the Developed Al/SiC-MMC's American Journal of Mechanical Engineering. 2013, 1(1), 14-19.

Optimization of significant parameter on Mechanical activities of AlMg1SiCu Fusion Metal Matrix Composites with Taguchi included Fuzzy Approach

- [5] Khalid Mahmood Ghauri, Liaqat Ali, Akhlaq Ahmad, Rafiq Ahmad, Kashif Meraj Din. Ijaz Ahmad Chaudhary³, Ramzan Abdul Karim Synthesis and Characterization of Al/SiC Composite Made by Stir Casting Method: Pak. J. Engg. & Appl. Sci. Vol. 12, Jan., 2013 (p. 102-110).
- [6] Prashant.S N Madev Nagaral and V Auradi Preparation And Evaluation of Mechanical And Wear Properties of Al6061 Reinforced With Graphite And Sic Particulate Metal Matrix Composites, IntJ.MechEng&Rob.Res, Vol 1, No.3 (p. 85-95).
- [7] S. Dhanalakshmi, N. Mohanasundararaju, P.G.Venkatekrishnan, Preparation and Mechanical characterization of stir cast hybrid Al7075-Al2O3-B4C Metal Matrix Composites, Applied Mechanics and Materials, Vols. 592-594 (2014) 705-710.
- [8] G. Vijaya Kumar and P. Venkataramaiah Optimization study on drilling of al-6061 with coated tools under MQL condition using hybrid approach Elixir Mech. Engg. 45 (2012) 7831-7839.
- [9] K.Hashmi*M.A.El Baradie**M.Ryan* Fuzzy logic based intelligent selection of machining parameters: Computers and Industrial Engineering, 35(3-4),1998 (p. 571-574).
- [10] Y. H. LEE, B. H. YANG and K. S. MOON An economic machining process model using fuzzy non-linear programming and neural network Lee Y.H et.al, International Journal of Production Research, 37(4), 1999 (p.835-847).
- [11] P. Shailesh, S. Sundarrajan, M. Komaraiah Optimization of Process Parameters of Al-Si Alloy by Centrifugal Casting Technique Using Taguchi Design of Experiments procedia material science 6(2014) pp812-820.
- [12] Vikas Mukhraiya, Raj Kumar Yadav and Pooja Tiwari, Optimization of Drilling Parameters Using Grey Based Taguchi Method. International Journal of Advanced Research in Engineering and Technology, 6(12), 2015, pp. 16-24
- [13] Ajeet Kumar rai, Shalini yadav, Richa Dubey and Vivek Sachan, Application of Taguchi Method in the Optimization of Boring Parameters, International Journal of Advanced Research in Engineering and Technology (IJARET), Volume 4, Issue 4, May – June 2013, pp. 191-199
- [14] Rachid Ouache, Ali A.J Adham, Noor AzlinnaBinti Azizan, Hybrid Layer of Protection Analysis and Bow-Tie Analysis with Fuzzy Approach for Quantitative Risk Assessment, International Journal of Advanced Research in Engineering and Technology (IJARET), Volume 5, Issue 10, October (2014), pp. 01-11