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Optimization of process parameters and machinability in milling analysis aluminium – zirconia composites

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Abstract

The current study deals with the optimization of mechanical properties of aluminum alloy (Al6061) metal matrix composites reinforced with merged zirconia bonded abrasive particles which were fabricated by sand casting method. The sample specimens were fabricated by varying the percentage of weight fraction of reinforced particles as 5, 10, 15 and the remaining aluminum alloy respectively. The mechanical properties were analyzed. The evaluation of mechanical properties indicates variations in hardness, MRR and surface roughness with respect to composite combinations. From the experimental studies, the optimum weight percentage of the matrix and reinforcement on the basis of mechanical properties was found to be 90 and 10 respectively.

Keywords—Aluminium , zincorina, MRR, Surface roughness,Hardness.

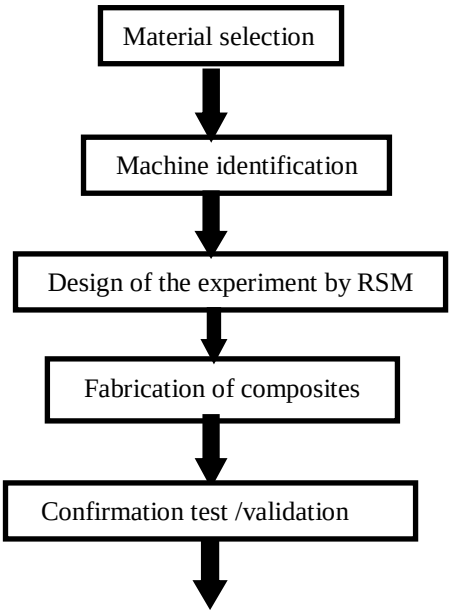
I. INTRODUCTION

A Composite is a combination of two or more dissimilar materials having a distinct interface between them such that the properties of the resulting material are greater than the individual constituting components. Composite material is composed of two or more constituent phase (i.e.): matrix phase and reinforcement phase. A Metal matrix composite is one of the types of composite in which the matrix phase is predominantly a metal or a metal alloy. The metal is the base material which constitutes the major part and the minor constituents are reinforcements that can be in the form of particles, continuous and discontinuous fibres. The MMC consists of superior properties such as high strength, high stiffness, and high electrical and thermal conductivity.

Aluminium is a perfect material to be designated as a matrix as it contains of necessary properties like profusion, truncated price, low density, high strength-to-weight ratio, controlled co-efficient of thermal expansion, increased fatigue resistance and superior dimensional stability at elevated temperatures.

2.METHODOLOGY

Our studies beings with selection of materials and then identify the machine for fabrication process. Select suitable software for solving many problems on materials. Select suitable composition for fabrication. Test specimen for various method and compare with other material value for selecting best composition.



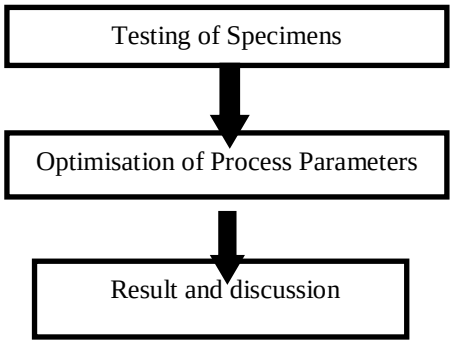


Figure 1 Aluminium6061

II. EXPERIMENTAL WORK

Selection of Materials

Among the other material aluminium is one of lightest and cheapest metal. Aluminium is one the metal, easily available in environment. It is a good conductor of heat and electricity and good resistance to corrosion. Aluminium is an abundant material on the earth after silicon and oxygen .Aluminium is easy to mould into desired shape and size by various moulding and casting process.

(a) Matrix

In this project aluminium 6061 is used

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Table1: chemical composition of Aluminium6061

Constituents	Percentage
Manganese(MN)	0.108%
Iron(Fe)	0.125%
Copper(Cu)	0.392%
Magnesium(Mg)	0.970%
Silicon(Sl)	0.620%
Chromium(Cr)	0.079%
Others(Total)	0.04%
Aluminium(Al)	97.7%

Table2: Mechanical properties

Density	2.70g/cm^3
Young's modulus	124-290 Mpa
Elongation	12-25%
Poisson's ratio	0.33

(b) Reinforcement

Zirconia is used as reinforcement in this study. Zirconium dioxide (Zro_2) is also known as Zirconia. It is white crystalline oxide of Zirconium. A dopant stabilise cubic structure Zirconia is synthesised in varies colour for use of gem stone and diamond simulant.

Table3: Properties of Zirconia

Chemical formula	ZrO2
Molar mass	123.218 g/mol
Appearance	White powder
Density	5.86 g/cm3
Melting point	2,715º C (4,919F 2,988K)
Boiling point	4300ºC (7,770F 4570 K)
Solubility in water	Negligible
Solubility	Soluble in HF, and hot H2SO4
Refractive index	2.13

Figure 2 Zirconia

3. Experimental Procedure

This experimental study begins with sand casting. Sand casting involves in use of a furnace, metal, pattern and sand mould. The materials is heated at certain temperature and after is melt is pour into sand. Initially furnace is heated to the required temperature crucible is placed inside the furnace and crucible is allowed heat unto heat condition .Then first piece 95% 0f aluminium is melted to mould state and then 5% of zirconia was added and then it was placed 5to 10 minutes. Once the raw material becomes molten it was poured in to the die. This method was continue for other two pieces with respective composition of 90% of Aluminium 10% of Zirconia and other composition of 85% of Aluminium and 15% of Zirconia. The dimension of the specimen is 50*50*35.

Figure 3:casting process

3.1 Milling Process

Milling is a machining process of using rotary cutters to remove materials from a work piece by advancing or feeding cutter into the work piece at a certain direction.

3.2 Types of MILLING CUTTERS

- End mill cutter
- Rack cutter
- Angle milling cutter
- Shoulder face milling cutter
- Milling cutter
- Polish mill cutter

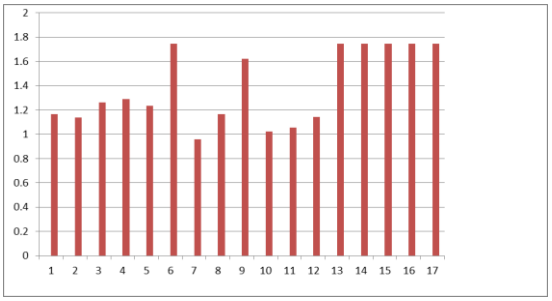
Figure 4.samples of milling process

After Machining Process, the workpecies have good surface finish and this used for various testing process.

Figure 5.samples of milling process

4 Result and Conclusion

4.1 Material Removal Rate

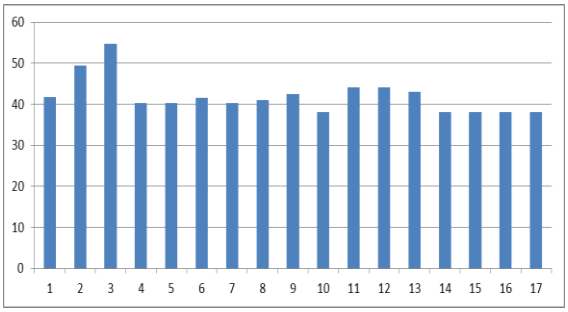


Above bar graph shows that material removal rate on material . The material remove based on feed and depth of cut. Material removal various based on parameters .

4.2 Briell hardness number

Hardness test is the method of measuring the hardness of a material by pressing a chromium- steel or tungsten-carbide ball against the smooth material surface under standard test conditions.

Figure 6.Brinell hardness machine



Brinell hardness number were different on each specimen according to composition on each materials.

4.3 Surface roughness test

Roughness testing is used to quickly and accurately determine the surface texture or surface roughness of a material. A roughness tester shows the measured roughness depth as well as the mean roughness value in microns.

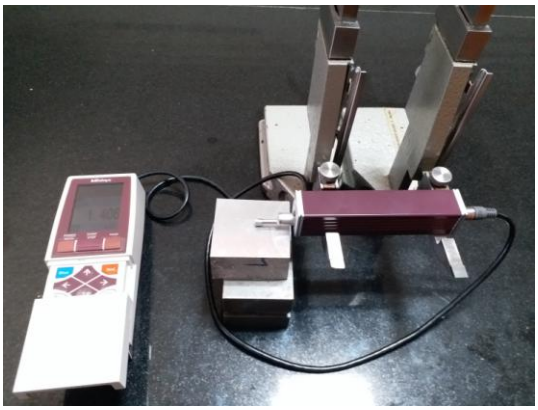
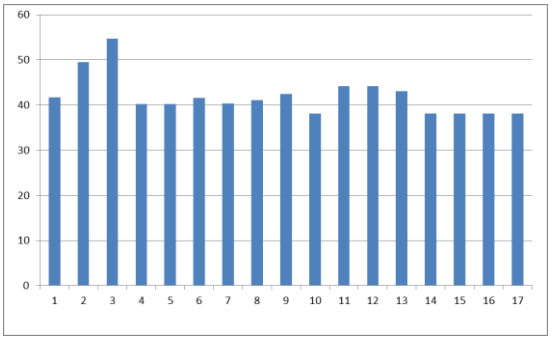


Figure 7.Surface roughness tester



Lower is the value best is the material

Conclusion

Various tests have been conducted on various specimens among that 10% weight of zirconia produced best results.

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