Mechanical properties and microstructure of Al-7075/Kyanite composites

Syed Saleem Pasha [1], Mohammed Imran[2], Dr.S.N Harish[3]

[1,2]*Research Scholar, Department of mechanical engineering, Ghousia College of Engineering, Ramanagaram-562159, Affilated to VTU.*
[3]*Professor, Department of mechanical engineering, Ghousia College of Engineering, Ramanagaram-562159, Affilated to VTU.*

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Abstract - *In this study Al 7075 alloy is chosen as matrix and kyanite particles having average size of less than 50μm was added into the base alloy at the liquid state fabricated by using stir casting method. Kyanite reinforcement is added by varying volume fraction of 2%, 4% and 6% in matrix material. The sample was prepared as per the ASTM standards. The mechanical properties and microstructural properties were studied such as, hardness, tensile strength, flexural strength, compression strength and impact strength of the Al 7075–kyanite composites are found to be increased by increased vol.% of kyanite particles. The optical microscopic structure shows uniform distribution of reinforcement material in base alloy.*

Key Words: Al-7075, Kyanite, Mechanical Properties, Microstructure.

1.INTRODUCTION

Aluminium and its alloys play a vital-part in different technological sectors such as automobile and aerospace sectors due to their superior in mechanical properties and weight to strength ratio. Aluminium matrix composites generally fabricated by liquid method of casting [1–4]. In the liquid casting technique, the reinforcement particulates are mechanically fine distributed over the liquid metal before casting and solidification [5–8]. These casting methods are typically less cost [9]. Aluminum based MMCs gives better mechanical properties than unreinforced aluminium alloys and are extensively using due to their higher strength to density ratio and improved mechanical strength This behaviour has been an reason for increasing interest towards the various applications in technological fields.

2. EXPERIMENTAL PROCEDURES

2.1 Preparation of Composites

2.1.1 Matrix Material

The base matrix chosen in the present study is the aluminum 7075 because it is one of the most extensively used of the 7000 series aluminum alloys. It is a versatile heat treatable extruded alloy with medium to high strength capabilities. Typical properties include medium to high strength, good toughness, good surface finish, and excellent corrosion resistance to atmospheric conditions, good corrosion resistance to sea water, good weld ability and brazability, good workability, widely available

Fig.1. Al 7075 obtained as billets

2.1.2 Reinforcement Material

Kyanite and its Properties our Kyanite is an industrial mineral concentrate that contains 48%-55% alumina by weight shown in fig.2

(a) Chemical composition (wt %)

Al_2O_3	SiO_2	TiO_2	Fe_2O_3	CaO	LoI
48.0 - 55.0	39.0 - 45.0	0.5- .6.0	0.80 - 1.75	0.52	1.65

(b) Physical properties

Particulate	Description
Specific Gravity	3.2 - 3.6
Hardness	4.0 To7.4 Mohr's Scale
Particle Shape	Finger-Crystal
Color	Yellow Gray

Fig.2. Kyanite particles

2.1.3 Preparation of Casting

The base material used is Al7075 alloy. The required amount of Al 7075 alloy was placed in crucible in an electric heating furnace to a temperature of about 750-800° C maintained. The base metal Al7075 taken as 3 kg for a casting and the reinforcement kyanite material with 0 vol.%, 2 vol.%, 4vol.% & 6vol.% of composites was prepared. The permanent mould and kyanite reinforcement material box was pre heated. The molten alloy was degassed (to prevent hydrogen gasses) and after a few minutes the slag formed was removed. The stirrer was carefully placed at a required depth in the crucible and stirred at 650rpm to form a vortox. The reinforcement material added in to vertox and stirred for about 5-10min to obtain a homogenous mixture. The molten mixture carefully poured into the moulds box to obtain the castings, which are later allowed to cool and checked for any defects in the castings shown in fig.3 & fig.4. Further samples were prepared as per the ASTM standards for the evaluation of mechanical properties of proposed composites.

Fig.3. Stir casting furnace

Fig.4. Casting Photograph

3. RESULTS AND DISCUSSION

3.1 Mechanical Properties

3.1.1 Hardness

Hardness tests were carried out on samples of both unreinforced alloy and its composites, by applying 40 grams of load for a period of 15 seconds using Brinell hardness tester as per ASTM E10 standard test method [10]. Fig.5 graph shows that the hardness increase with weight percentage of reinforcement in Al7075 matrix alloy and observed higher hardness in composite compare to matrix material.

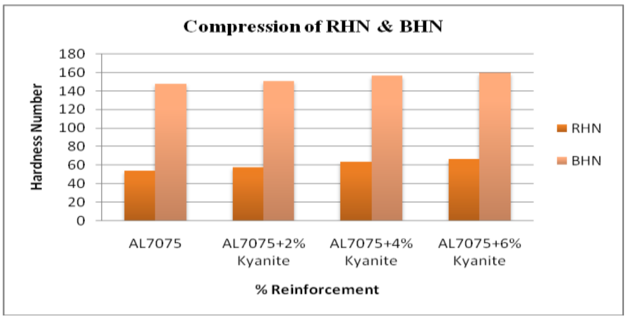


Fig.5. Comparison of Hardness

3.1.2 Tensile strength

Tensile test were carried out on samples of both unreinforced alloy and its composites, by using UTM as per ASTM E8M standard test method [10]. Fig.6 graph shows that, the ultimate tensile strength is increases with increase in weight percentage of reinforcement in Al7075 matrix alloy and observed composite has superior UTS by the addition of kyanite particles in matrix material. It is clears that Al+6%kyanite composite has higher strength compared to base alloy.

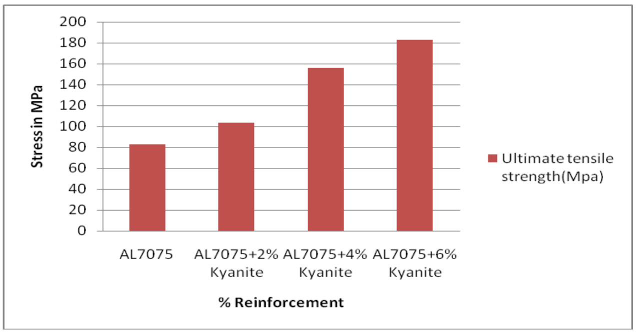


Fig.6. UTS of composites

3.1.3 Compressive strength

Fig.7 graph shows that, the compressive strength is increases with increase in weight percentage of reinforcement in Al7075 matrix alloy and observed composite has superior ultimate compressive strength with the addition of kyanite particles in matrix material. It is clears that Al+6%kyanite composite has higher compressive strength compared to base alloy.

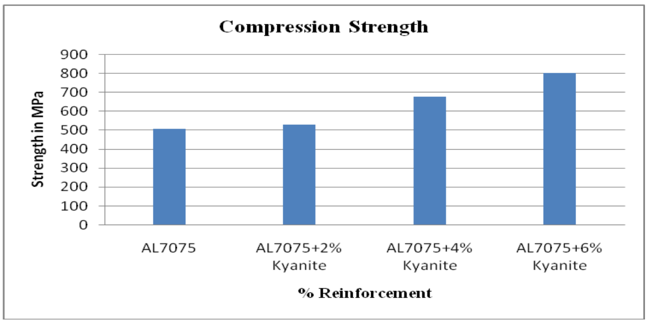


Fig.7. Compressive strength of composites

3.1.4 Impact strength

Impact test were carried out on samples of both unreinforced alloy and its composites, as per ASTM E23 standard test method Fig.8 graph shows that, the impact strength is increases with increase in weight percentage of reinforcement in Al7075 matrix alloy and observed composite has superior energy absorption with the addition of increasing in up to 6%kyanite particles in matrix material. It is clears that Al+6%kyanite composite has higher impact strength compared to base alloy.

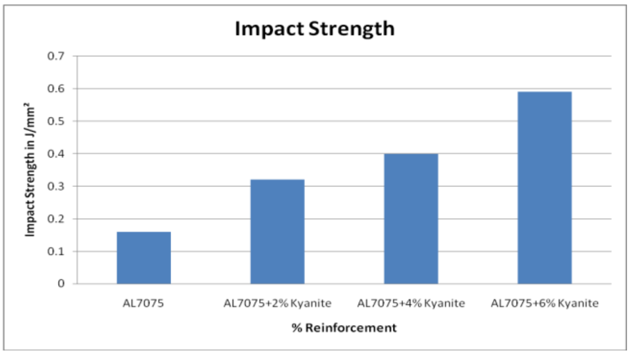


Fig.8. Impact strength of composites

3.1.5 Bending strength

Flexural test were carried out on samples of both unreinforced alloy and its composites. Fig.9 graph shows that, the flexural strength vary with increase in weight percentage of reinforcement in Al7075 matrix alloy and observed Al+4%kyanite composite has higher flexural strength compared to base alloy.

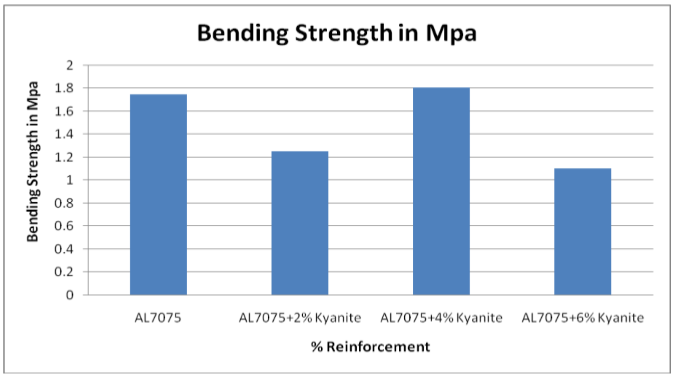
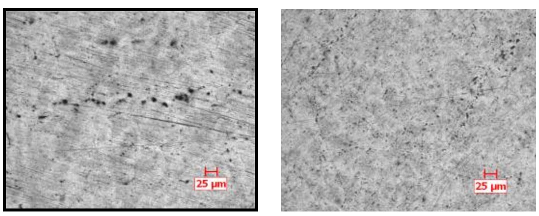
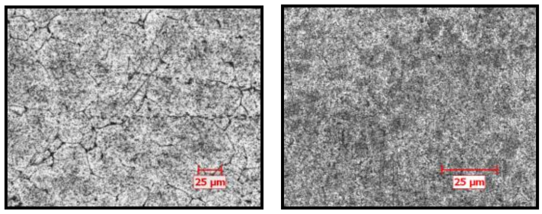


Fig.9. Bending strength of composites

3.2 Microstructure



(a) Al7075 (b) Al7075/2%K



(c) Al7075/4%K (d) Al7075/6%K

Fig.10. Microstructure photographs of composites

Optical microstructure is carried to analyze the distribution of reinforcement in matrix. it was observed from the photograph of microstructure uniform distribution of kyanite particles throughout the matrix material.

4. CONCLUSIONS

- Al–Al_2SiO_5 composites have been successfully prepared by vertox technique. Up to 6wt% - Al_2SiO_5 has been successfully dispersed in the matrix.
- This study was to observe the effects of kyanite particulates reinforcement impoves mechanical properties of aluminium matrix.
- It is 54.66% UTS of Al+6%kyanite composite has higher compared to base alloy.
- It is 36.43% compressive strength of Al+6%kyanite composite has higher compared to base alloy.
- Hardness and ultimate compression strength is increased with increasing in weight percentage of reinforcement and reached to maximum due to uniform distribution of kyanite particles in matrix material.

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BIOGRAPHIES

Research Scholar, Department of mechanical engineering, Ghousia College of Engineering, Ramanagaram-562159, Affilated to VTU

Research Scholar, Department of mechanical engineering, Ghousia College of Engineering, Ramanagaram-562159, Affilated to VTU

Professor and Guide, Department of mechanical engineering, Ghousia College of Engineering, Ramanagaram-562159, Affilated to VTU.