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Experimental Performance analysis of Al-7075 Hybrid composites

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ABSTRACT- *The demand for advanced materials with light weight and high strength is high in the field of automobile, aerospace and aviation industries. There are various techniques of liquid metal casting process, among them stir casting is most popular one. Preparation of composites with dispersoid is being done by stir casting technique, since it is most economical from last two decades. In this techniques tough task is that the wetting of reinforcement in to a liquid metal. The present works zooms on Al-7075 hybrid composite with hard reinforcement as TiO_2 and soft reinforcement as calcium fluoride. The weight percentage of hard reinforcement is added as 5% and 10%, with the soft reinforcement as 1%wt. The important aim of this work is to develop a hybrid composites with higher mechanical properties compared to the base alloy Al-7075. It is observed that the increase in the content of TiO_2 with small 1-wt% of CaF_2 dispersoid, increases certain mechanical performance like hardness, strength and ductility. However when inspected, the Al-7075 hybrid composites showed improved properties.*

Key words – Dispersoid, Stir casting, reinforcement, TiO_2, Calcium fluoride

1 INTRODUCTION

There is increasing trend towards the use of advanced materials with light weight and high strength, with a view to increase the performance in engineering materials. Application of Al hybrid composites not only applicable to smaller level but also it plays an eminent role in major level such as structural application, aerospace and automotive industries, owing to their low density, high specific strength and stiffness[2]. These hybrid composites are developed in order to improve the machining properties and wear properties. Aluminum being soft metal exhibit poor hardness and strength, which when reinforced with a hard ceramic contents its performance get improved in terms of hardness and strength. On the other side when aluminum is reinforced with a soft reinforcement, its performance such as ductility and softness increases[1]. The main objective of this work is to develop a new class of Al7075 hybrid metal matrix composites with superior properties compared to the monolithic alloy. TiO_2 is the most accepted ceramic form of reinforcement due to its high hardness and low coefficient of thermal expansion.

2 COMPOSITE PREPARATION

The preparation of composite is a challenge task starts from the base of sintering, melting to the pouring of the molten metal in to mould cavity. A first batch of casting is done for Al-7075 base alloy in the electric furnace and the metal is heated till alloy get melted. By the time the alloy get melted, it is further heated to 100°C more from the melting point at 750°C and the molten metal is degassed with the addition of standard degassing tablets. The impurities are removed from the molten metal in the form of slag contents and cuprit powder was added to the molten metal to obtain better flow ability. Similarly the second and third melt is prepared with 5-wt% and 10-wt% of TiO_2 along with 1-wt% of CaF_2. The mechanical stirring is carried out as shown in figures 1. The reinforcement are sintered around 200°C for the time period of 1 hour and the mould used is a metallic mould which is preheated. Hence the molten metal is agitated with constant stirring using mechanical stirrer and the sintered reinforcement are added to it at constant rate. Therefore care should be taken that the added reinforcement should be distributed properly inside the metal matrix. Finally obtained hybrid mixture is poured into a preheated mould cavity.

Figure-1shows the overview of preparation of hybrid composites

The castings are removed from the mould and the specimen are prepared for microstructure, microhardness and tensile test as per ASTM standard for each test.

2(a)

2(b)

2 (c)

Figure – 2a, 2b and 2c show the specimen used for mechanical test such as micro hardness, wear test and tensile test

3 Results and discussion

3.1 Microstructure

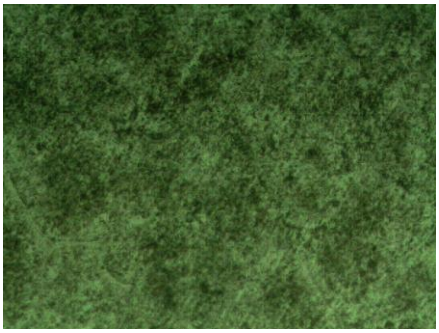

Figure 3 a

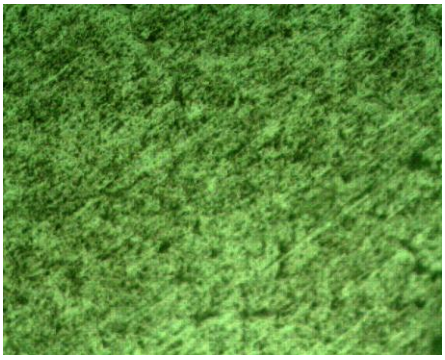

Figure 3b

Figure 3c

Figure- 3a,3b and 3c Shows the microstructure of Al7075, Al7075-5-wt%TiO_2 1-wt%CaF_2 and Al7075-10-wt%TiO_2 1-wt%CaF_2

It is analysed the distribution of TiO_2 and CaF_2 particles are fairly homogenously distributed. The accumulation of reinforcement particles are also found in some composites with higher percentages of titanium dioxide particles. The figure 3a shows the microctrucutre of Al7075, it consists of fine intermetallic precipitates in a matrix of aluminium solid solution, eutectic melting is not seen and segregation or porosity was not seen.

The figure 3b, shows the microstructure of Al7075-5wt%TiO_2- 1-wt% CaF_2, it consist of fine intermetallic precipitates in a matrix of aluminum solid solution with homogenous distribution of reinforcement and the porosity was not observed in the section. Refinement is also seen

The figure 3c, shows the microstructure of Al7075-10-wt%TiO_2- 1-wt% CaF_2, it reveals that the reinforcement added get distributed as a single phase with matrix element. However the clustering of reinforcement is more in this case.

3.2 HARDNESS TEST

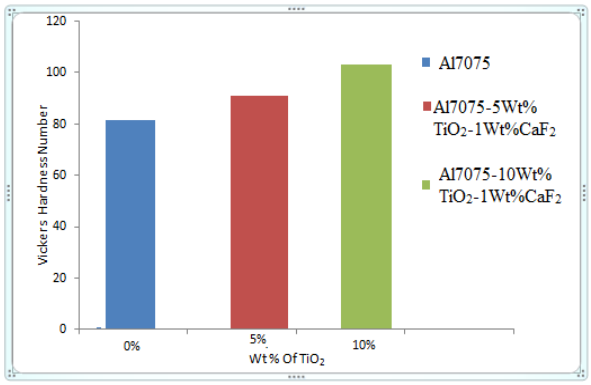

Figure-3.2 shows the variation of hardness with varying TiO_2

The above figure shows the hardness of aluminum alloy and it's hybrid composites. It is observed that with the increase in content of hard reinforcements, hardness of the hybrid composites improved and the highest hardness is observed in case of higher content of TiO_2.

3.3 TENSILE TEST

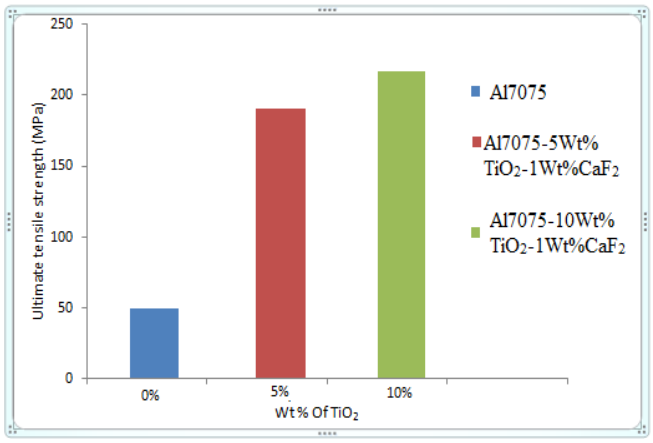

Figure-3.3 shows the variation of Ultimate tensile strength with varying TiO_2

Figure shows the variation of ultimate tensile strength of Al7075 matrix alloy and its cast hybrid composites. It is revealed that the developed hybrid composites exhibit ultimate tensile strength. When compared with the cast Al7075 matrix alloy. A maximum improvement is observed in case of Al7075 hybrid composite with 10wt% percentage of TiO_2 and minimum improvement is observed in 5wt% percentage of TiO_2.

4 CONCLUSION

1. Casting of Al7075 and its hybrid composites is successfully carried out
2. Superior quality of hybrid MMC with less voids using ceramic reinforcements is developed
3. A maximum improvement is seen in case of Al7075-10wt%TiO_2-1wt%CaF_2 in terms of mechanical properties such as strength, hardness and ductility.
4. Homogenous distribution of reinforcement is seen in developed hybrid composites.

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