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Effect of Deep cryotreatment on Hardness and Tensile strength of Aluminium 6061-Sic composites

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Abstract

Aluminium alloys are widely used in aerospace and automobile industries due to their low density and good mechanical properties, better corrosion resistance and wear, low thermal coefficient of expansion as compared to conventional metals and alloys. The excellent mechanical properties of these materials and relatively low production cost make them a very attractive candidate for a variety of applications both from scientific and technological viewpoints. In the present investigations an attempt has been made to know the effect of cryotreatment on Thermal Conductivity, Hardness, Tensile strength, Deep cryo treatment on Al-6061 reinforcing with varying SiC contents. The composite is prepared by stir casting process in an electric melting furnace. The experimental study is performed varying weight % of Silicon carbide powder with pouring temperature and stirring time as constant.

Keywords: Aluminium Metal Matrix Composite, Stir Casting, Reinforcement Silicon Carbide, Taguchi Method

1. Introduction

Now days with the modern development need of developments of advanced engineering materials for various engineering applications goes on increasing. To meet such demands metal matrix composite is one of reliable source. Composite material is one of the reliable solutions for such requirement. In composites, materials are combined in such a way as to enable us to make better use of their parent material while minimizing to some extent the effects of their deficiencies. The simple term 'composites' gives indication of the combinations of two or more materials in order to improve the properties. In AMC one of the constituent is aluminum, which forms percolating network and is termed as matrix phase. The other constituent is embedded in this aluminum and serves as reinforcement, which is usually non metallic and commonly ceramic such as SiC, Al2O3,B4C etc.(1,2,3,4) Al 6061 is quite a popular choice as a matrix material to prepare MMCs owing to its better formability characteristics. It is widely used in numerous engineering applications including transport and construction where superior mechanical properties such as tensile strength, hardness etc. are essentially required.(6,7)

To further increase the properties of these composites several process like heat treatment for whole material and surface processing is also being carried out, In other hand cryogenic treatment also known as subzero treatment is done which is very old process and widely used for the high precision parts and objects especially for the ferrous and tooling materials earlier(8). The subjecting of the material to extreme cold hardens, strengthens and molecular alignment in the micro level is fine and smooth the material has longer life (9). Now the cryogenic treatment which is whole material treatment is widely used in many automotive, aerospace, electronic and mechanical engineering industries to improve mechanical strength and dimensional stability of components For the past few years the cryogenic treatment for the nonferrous metals such as aluminium and magnesium alloys has been done for the their improvement of properties (10). The improved mechanical properties and microstructure changes of the metals and alloys in cryogenic processing drew the attention of researchers towards this process. The researchers (11, 12, 13, 14) showed the beneficial effects of cryogenic treatment on nonferrous metal aluminium. The effect of cryogenic treatment on the wear performance of copper alloy showed least significant changes (15). This lead to the idea of analyzing the properties when MMCs is undergoing cryogenic treatment. This field is rapidly growing and is used by many manufacturers. The present work intends to construct a facility to research the process and results of the cryogenic treatment. This helps to create standards for both processing and testing that are currently unavailable. Hence it gives importance that mechanical properties of the MMCs developed are evaluated at cryogenic temperatures. Thus in this experimental work cryogenic treatment was applied to Al6061/SiC MMCs to study its effect on , Hardness, andTensile strength

2.0. EXPERIMENTAL SET UP AND PROCEDURE

Al6061-SiC composite are for combination of **2, 4, 6 and 8%** SIC are casted by using stir casting process for combination of **2, 4, 6 and 8%** SIC are casted by using stir casting process.(4) Then the jobs are subjected for Deep cryotreatment process. The jobs are cooled down to Deep Cryotemperature **-196^0** c at a rate of **3^{0}c**/min from room temperature in computerised Cryo Processor, soaked at that temperature for a period of **24** Hrs and then bring back to room Temperature at a rate of **3^{0}c/min**. then the Deepcryotreated specimen tested for various Properties and compared with Untreated samples.

2.1 Hardness test.

Brinell hardness has been measured for reinforced alloy and hybrid composites developed using Al 60613wt. % as the alloy with the Sic particles added as reinforcements in amount of 2, 4, 6 and 8 wt.% respectively.

The Brinell hardness has been measured for unreinforced alloy and cast composites with 5 mm hardened steel ball indenter of 100 Kg load was applied for 30 seconds on a sample and then the diameter of indentation was measured with help of tool maker's microscope.

For each indentation, an average of two diameters measured perpendicular to each other was used to find the corresponding hardness. On each sample at-least eight indentations for hardness measurement were made at different locations and the average of these readings is reported as the average hardness value of the material. Brinell hardness number has been found out by using Standard formulae

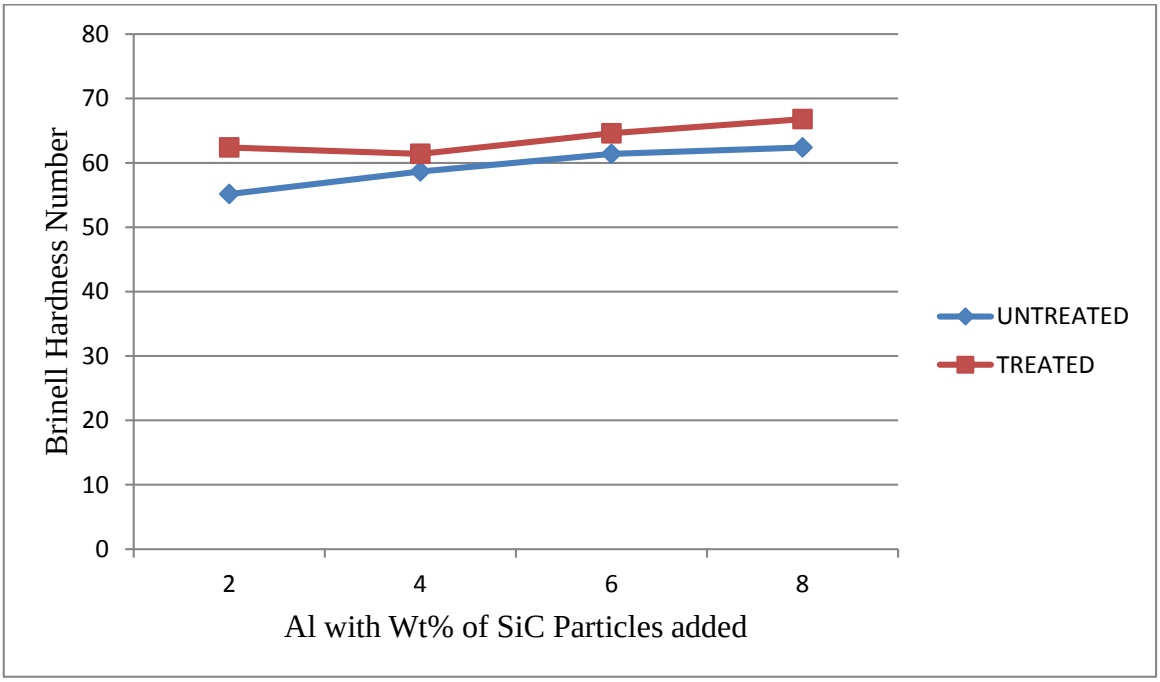

Fig 1: Indicating the variation in hardness number for different percentage of SiC particles

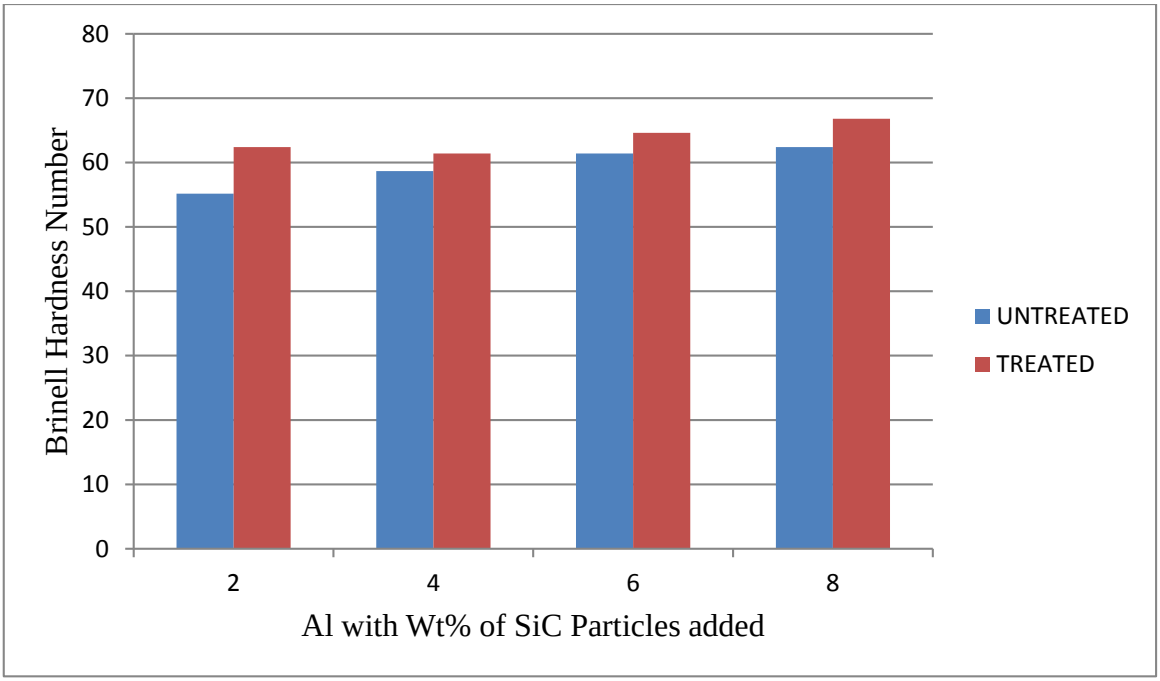

Fig 2: Bar chart shows variation in BHN between Untreated and Deep Cryotreated Al6061-SIC Composites.

From fig (1) and fig (2) indicates that as the percentage of SIC increases hardness value also increases. But Deep Cryotreatment on composites has helped in increasing the hardness on composites due to Improvement in wear resistance This is in concurrence with the investigation has carried out by Earlier investigators.(11,12,13,14,15)

2.1 Tensile test.

Tensile test is carried out on UTM as per standard procedure on below tensile test specimen as indicated in fig (4) and values are recorded at maximum load bearing capacity of the job and correspondingly tensile strength has been assessed by using formulae

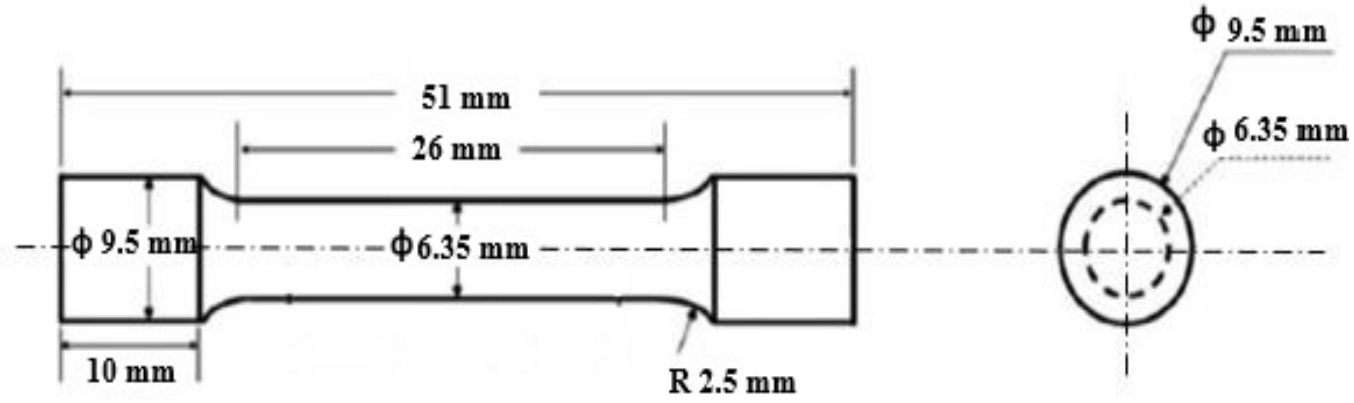

Fig. 3: Schematic representation of tensile specimen ASTM E8 standard

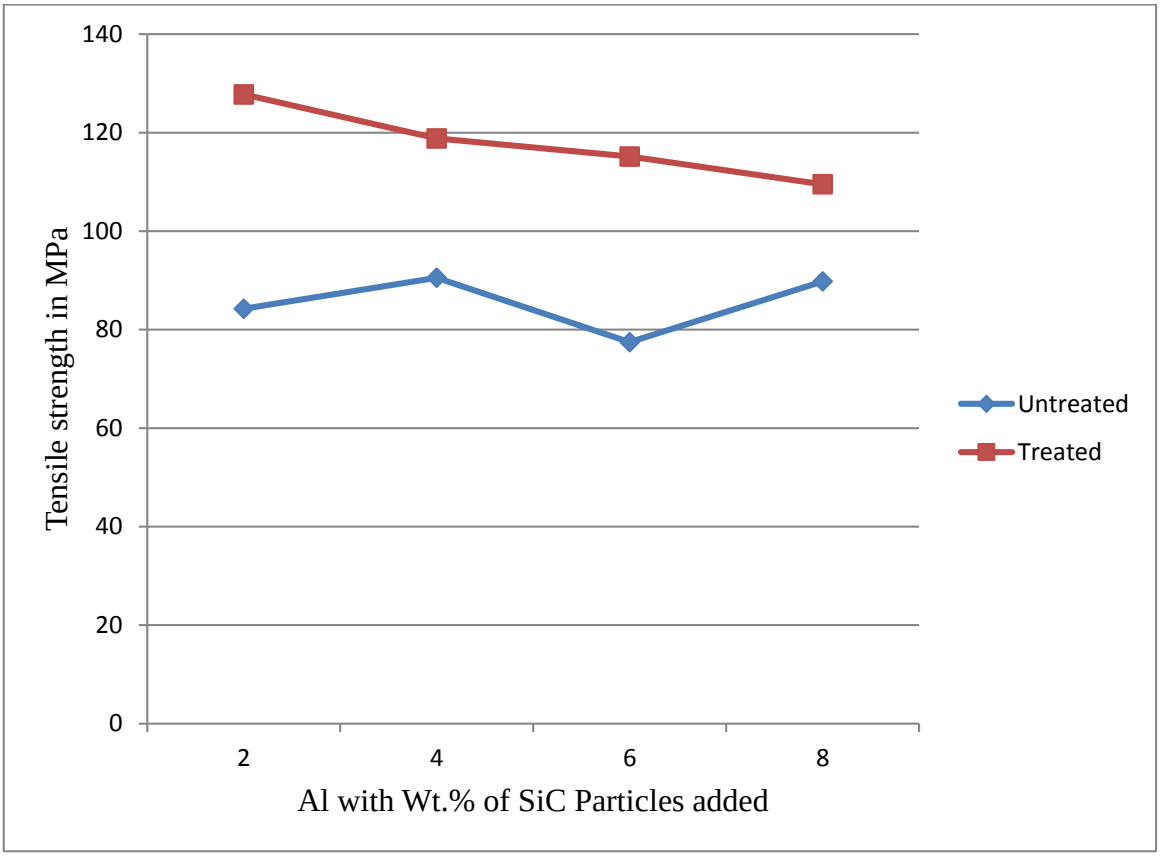

Fig. 4: Indicating the variation in tensile strength for different percentage of SiC particles

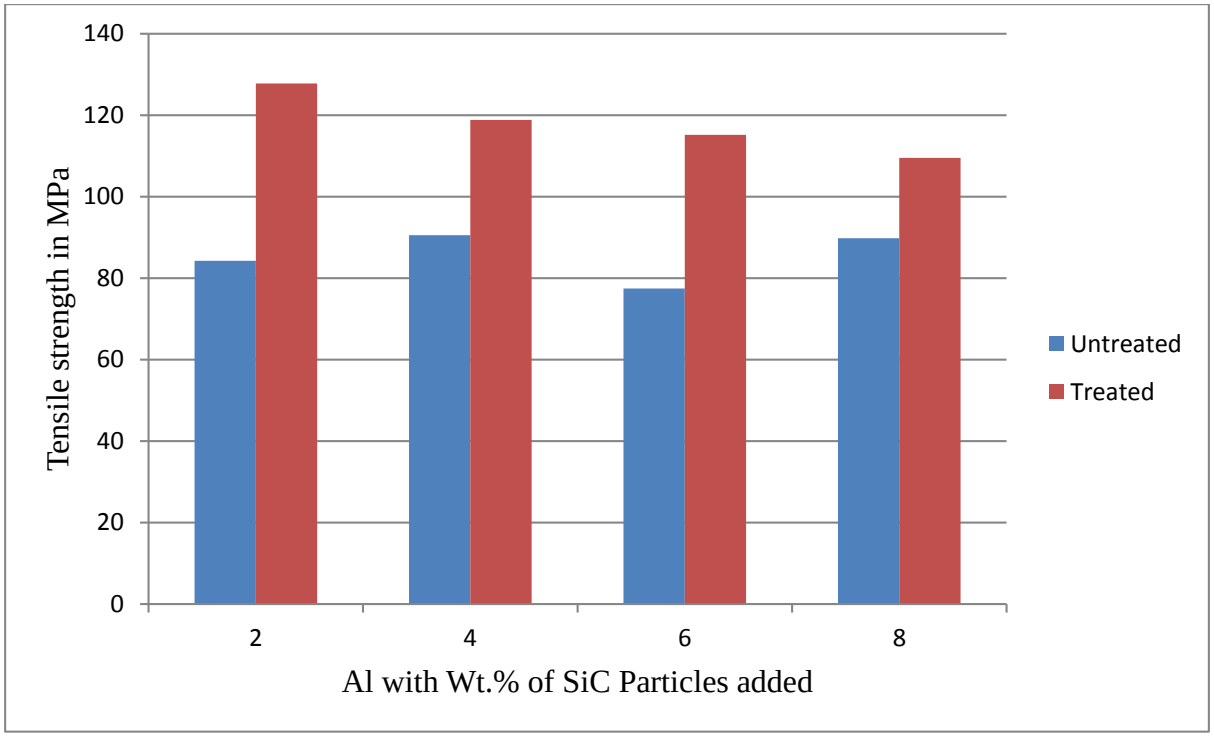

Fig 5: Bar chart shows variation in tensile strength between Untreated and Deep Cryotreated Al6061- SIC Composites

From fig (4) and fig (5) indicates that as the percentage of SIC increases tensile strength also decreases. But deep Cryotreatmen helps in improving toughness on composites, which in turn has reduced the tensile strength on composites without incurring loss to its hardness property. Deepcryotreatment on composites optimizes both hardness and tensile properties This is in concurrence with the investigation has carried out by indicates that as the percentage of SIC increases hardness value also increases.(11,12,13,14,15)

3.0 CONCLUSION

The aluminium metal matrix composites have produced successfully by the addition of 2, 4, 6 and 8 wt.% of Silicon carbide (SiC) powder to molten Al 6061 alloy by liquid stir casting method followed by casting in permanent mould. The influence of increasing amount of SiC powder addition has helped in increasing the mechanical properties.

The conclusions of the present study are outlined below.

1) Stir casting technique (Liquid Metallurgy) was successfully adopted in the preparation ofAl6061 SiC alloy and composites containing 2, 4, 6 and 8 wt. % of SiC powder reinforcement

2) The hardness of the composites is found to increase with the increase in reinforcement of SiC and the higher hardness noticed for the 8 wt% of SiC powder addition.

3) The composite with 2 wt.% of SiC powder addition exhibited good, tensile strength of 127.768 MPa

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