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INVESTIGATION ON THE INFLUENCE OF GRAPHITE ON MECHANICAL PROPERTIES OF ALUMINUM-BORON CARBIDE COMPOSITES

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Abstract

Many of our modern technologies require materials with unusual combinations of properties that cannot be met by the conventional metal alloys, ceramics, and polymeric materials. Material property combinations and ranges have been, and are yet being, extended by the development of composite materials. Aluminium metal matrix reinforced with Boron Carbide (B4C) is a novel composite, which is used in many engineering Applications due to high wear resistance, high strength to weight ratio, elevated temperature toughness and high stiffness. Graphite is a form of carbon and Solid lubricant which display unusual combination of properties and hence have unique and emerging application. Aluminium 6061- B4C dispersed with graphite has been established as potential engineering materials of a number of antifriction applications. The addition of graphite particles is affecting the mechanical properties of the composites. This Papaer deals with the investigation of influence of this graphite particle in these composites at various conditions. It is observed that increasing the graphite content within the aluminum matrix results in significant decrease in ductility, hardness, ultimate tensile strength. The addition of boron carbide conversely increased the hardness of the composites.

Keywords: Al 6061, Boron Carbide, Graphite, Stir Casting

1. Introduction

Composite materials are important materials as they offer several outstanding properties as compared to conventional materials. Material property combinations and ranges have been, and are yet being, extended by the development of composite materials A composite material is a combination of two or more chemically distinct and insoluble phases and the properties and structural performance of a composite are superior to those of its constituents when acting independently. Composites are artificially produced multiphase materials having a desirable combination of the best properties of the constituent phases. Usually, one phase (the matrix) is continuous and completely surrounds the other (the dispersed phase). Aluminum matrix composites (AMCs) are attractive materials for structural applications in aircraft, automotive and military industries. High strength to weight ratio, environmental resistance, high stiffness and good wear resistanceBoron carbide (B4C) is one of the most promising ceramic materials due to its attractive properties, including high strength, low density (2.52 g/cm3), extremely high hardness (the third hardest material after diamond and boron nitride), good chemical stability and neutron absorption capability.

Aluminum6061-Boron Carbide-graphite Composite was prepared by double step stir casting method. The combination of all elements has been made in varying proportions. The fabricated composites of were subjected to mechanical testing such as tensile test, hardness test and impact test. It is observed that increasing the graphite content within the aluminum matrix results in significant decrease in ductility, hardness, ultimate tensile strength, and yield strength. The addition of boron carbide conversely increased the hardness and ultimate tensile strength of the composites.

2. Experiment details

Stir Casting

Two step stir casting method was used to fabricate the Al- B4C -Graphite. stir-casting is the process of stirring molten metal's are used for continuous stirring particles into metal alloy to melt and immediately pour into the sand mould then cooled and allow to solidify.In stir-casting, the particles are often tends to form agglomerates, which can be only dissolved by vigorous stirring with high temperature. The whirlpool technique provides the high strength homogeneous set of aluminium composite materials.

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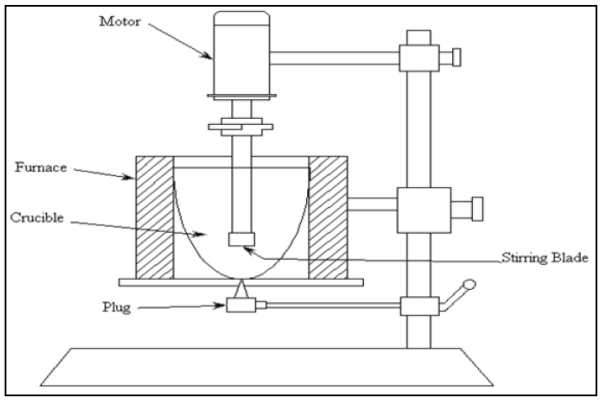


(Fig. 10) Line diagram of the stir casting process.

In the preparation process of this method, stirring has been carried out in graphite crucible in coal-fired furnace with continuous stirring of the molten metal-matrix gives homogeneous mixture of composites and instantaneously poured in to the sand mould to get solidify. Coal is used as a fuel for preparation. Uniform distribution of the boron carbide particles in the matrix phase can be obtained

Material Composition

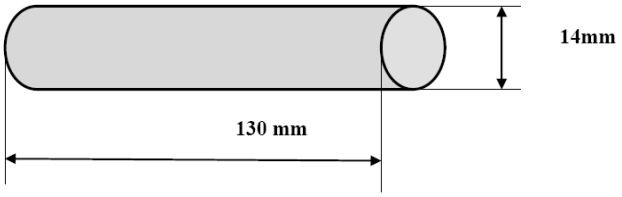
The Al 6061 is taken as the matrix and B4C as the primary reinforcement. The Graphite is taken as the secondary reinforcement. The All 3 were casted under the given compositions. In order to obtain T6 property of Al-6061 alloy, solution heat treatment was carried out over the material and it was heated up-to 520oC in muffle furnace. After reaching required temperature, the composite material was maintained for definite holding time at 520^{o}C.

Specimen NO:	Graphite (%Wt) [G]	AL6061 (%Wt) [A]	B_4C (%Wt) [B]
A90B5G5	5%	90%	5%
A85B10G5		85%	10%
A80B15G5		80%	15%
A85B5G10	10%	85%	5%
A80B10G10		80%	10%
A75B15G10		70%	15%

(Table of Material Composition)

Casting And Mechanical Testing

Composites were cast into a cylindrical rod in 14 mm diameter and130 mm length though stir casting methods.Each combination consiste of 4 castings to perform mechanical testings.If a material is to be used as part of an engineering structure that will be subjected to a load, it is important to know that the material is strong enough and rigid enough to withstand the loads that it will experience in service. The composites undergone tensile test and hardness test.

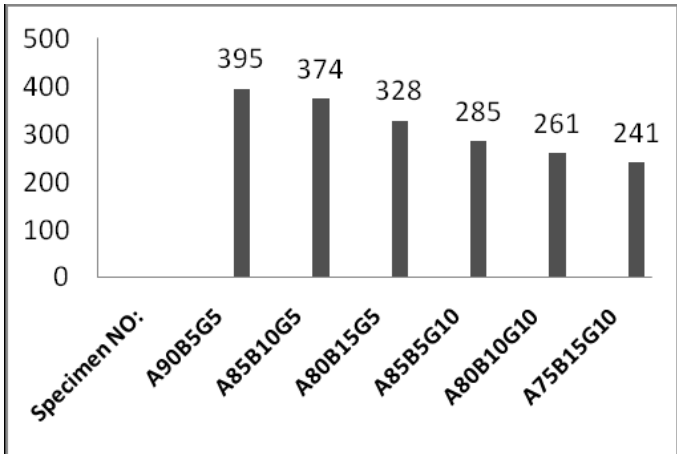


(Size of the casting)

3. Results

Specimen NO:	Tensile Strength (Mpa)	Brinell Hardness Number (BHN)
A90B5G5	395	58
A85B10G5	374	67
A80B15G5	328	79
A85B5G10	285	38
A80B10G10	261	44

It is observed that decrease in tensile strength of produced composite material with increasing in boron carbide particles. This is due to inadequate interface bond between particulates and matrix. Hardness of Al composites with varying % level of graphite for constant (5,10 &15%) of B4C particles. It is understood from the results, addition of graphite paricles decreases the hardness of the composite. The reason for decreasing hardness while adding Graphiteis soft nature of the graphite. It can be seen that the addition of B4C particles improves the mechanical properties of the resulting composite. It is observed that increasing the percentage of B4C in Al matrix, hardness of the composite is increased due to pinning down the dislocations.



(Tensile Strength) Graphite (5 % and 10%)

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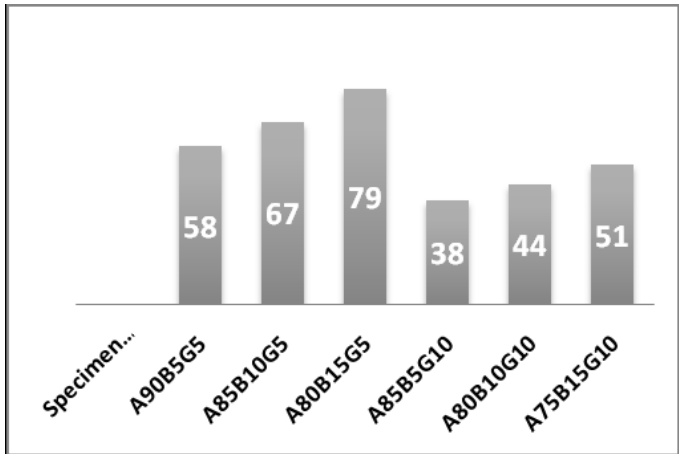

(Brinell Hardness)Graphite (5 % and 10%)

5.Tribological Properties Of Composite

The self lubricating effect of graphite is necessary for the lead free Aluminium-Boron Carbide contact materials. The addition of graphite improves the machinablility. Addition of graphite particles decreases the hardness of the composite. The reason for decreasing hardness while adding graphite is soft nature of the graphite. nano graphite particles can easily scattered in the matrix when nano graphite particles amounts to 1% which can decrease the coefficient of friction of the composite material. But the material of wear extent increases accordingly along with the increase of the content of graphite.

6.Conclusions

The results of mechanical testing of coarse grained graphite and Al 6061-B4C reveals that the hardness of the composite is increased with increasing of boron carbide particles in Aluminium matrix. The hardness of the composite is decreased with increasing of graphite particles in Aluminium matrix. It is observed that decrease in tensile strength of produced composite material with increasing in boron carbide particles. Also the wear resistance of the composites increased by increasing the B4C.

6. Referances

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