Fabrication and Testing of Al6061 TiB2 Graphite by Powder Mettalurgy Technique

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Abstract: Conventional monolithic materials have limitations in achieving good combination of strength,stiffness, toughness and density. To overcome these shortcomings and to meet the ever increasingdemand of modern day technology, composites are most promising materials of recent interest. Thepresent research work involves the study of Al 6061-TiB2 composite through powder metallurgy. Thismethod involves formation of reinforcements within the matrix by the chemical reaction of two or morecompounds which also produces some changes in the matrix material within the vicinity. TitaniumDiboride (TiB2) was the reinforcements in the matrix of Al 6061 alloy which can be suitable for space,aircraft and automotive components at elevated temperatures. The mechanical properties in terms ofhardness and impact test were carried out. The sample of Al 6061 alloy was also casted and tested forcomparison.

Keywords: Al6061Alloy,Tib2,MetalMatrixComposite,NanoComposites,powdermetallurgy,HardnessTestandWearRate.

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INTRODUCTION

Composites are manmade materials consisting of one or morediscontinuosphases having intimate contact with each other, which are cognizable interface between them. These are multifunctional materials system that provide. In general, the discontinuous phase is harder and stronger than the continuous phase and is called the 'reinforcement'; whereas continuous phase is termed as the 'matrix'. The matrix holds reinforcement to form the desired shape and bears the major portion of an applied load, while the reinforcement improves overall mechanical properties of the matrix. Reinforcement increases the strength, stiffness, wear resistant and the temperature resistance capacity and lowers thedensity.

STRUCTURE OF PAPER

The paper is organized as follows: In Section 1, the introduction of the paper is provided along with the structure, important terms, objectives and overall description. In Section 2 we discuss related work. In Section 3 We have given the Experimental work i.e process involved in powder mettalurgy A Section 4we have giv*en* results and analysis discussed in the abstract. Section 5we have given the conclusion and future scope 6 It includes References.

OBJECTIVES

Titanium Diboride (tib2) is an extremely hard ceramic which has excellent heat conductivity, oxidation stability and wear resistance. It is also a reasonable electrical conductor so it can be used as a cathode material in aluminium smelting and can be shaped by electrical discharge machining. Tib2 is extensively used as evaporation boats for vapor coating of aluminum. It is an attractive material forth aluminum industry as an inoculant store fine the grain size when casting aluminum alloys, because of its wet ability by and low solubility in molten aluminum and good electrical conductivity. Tib2 in the form offline powder can be used to provide wear and corrosion resistance to a cheap and/or tough substrate. An attempt thus been made to fabricate Al-6061 alloy based composites by using Tib2 case reinforcement and Al6061-tib2-Gr study the mechanical properties and deformation behavior of these resultantcomposites.

RELATED WORK

Powder metallurgy (PM) is a metal working process for forming precision metal components from metal powders. The metal powder is first pressed into product shape at room temperature. This is followed by heating (sintering) that causes the powder particles to fuse together without melting.

The parts produced by PM have adequate physical and mechanical properties while completely meeting the functional performance characteristics. The cost of producing a component of given shape and the required dimensional tolerances by PM is generally lower than the cost of casting or making it as a wrought product, because of extremely low scrap and the fewer processing steps. The cost advantage is the main reason for selecting PM as a process of production for high – volume component which needs to be produced exactly to, or close to, final dimensions. Parts can be produced which are impregnated with oil or plastic, or infiltrated with lower melting point metal. They can be electroplated, heat treated, and machined if necessary.

1 Mixing:

A homogeneous mixture of elemental metal powders or alloy powders is prepared. Depending upon the need, powders of other alloys or lubricants may be added.

2 Compacting:

A controlled amount of the mixed powder is introduced into a precision die and then it is pressed or compacted at a pressure in the range 100mpato 1000Mpa. The compacting pressure required depends on the characteristics and shape of the particles, the method of mixing, and on the lubricant used. This is generally done at room temperature. In doing so, the loose powder is consolidated and densified into a shaped model. The model is generally called "green compact." As is comes out of the die, the compact has the size and shape of the finished product. The strength of the compact is just sufficient for in process handling and transportation to the sintering furnace.

3Sintering:

The majority of metals can be sintered.Powder sintering is used to increase the strength and structural integrity of metal powders.The sintering process in metallurgy follows the fusing of metal powders,along with other materials such as alloying elements,using heat treatment in a single,elongatedfurnance with different temperature

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zones.The sintering temperature is always below the melting point of the material to avoid melting.

The first stage of metal powder sintering involves the materials being heated in the furnace at a temperature rate that induces the creation of martensitic, crystalline structures. Complete compaction does not occur because the sintering temperature is not high enough to melt the particles. Consolidating the materials can be accomplished through various means, including using tools to press the materials together or 3D printing lasers which can partially melt powders.The particles can also be joined by cold welds to give the powder compact enough strength for the rest of the sintering process.

The particle's density increases and they eventually merge.Two common ways to achieve this are transient liquid phase sintering and permanent liquid phase sintering.If the sintering powder compact involves iron, then the transient liquid phase sintering is used.In this process,copper powder is added to the iron powder.at the regular sintering temperature,copper melts and infuses with the iron, hardening the materials together.In the permanent liquid phase method,liquid materials such as cemented carbides are added and flow into the open pores and cracks,further binding the materials together.

By this powder sintering stage, the original sintering powder materials have now become a mostly solid form. In the final stage of permanent liquid phase sintering, more liquid and binder additive flows into any open cracks or pores, successfully binding together the packed mass.Sintering has a few different uses. One of the key uses of sintering is to join metal particles together—sintering is often used on metals with high melting points, since it doesn't rely on reaching melting temperatures to work.

Some 3D printing devices operate by sintering metals one layer at a time to create custom metal forms. Sintering a metal for 3D printing could help to save energy compared to melting the same metal, and allows for greater control and consistency, since the material isn't being completely liquefied. However, thisleaves more microscopic gaps than the full liquefaction caused by melting would.

EXPERIMENTAL WORK:

Composition:

S.no	Material
1	Al6061+2.5%Tib2
2	Al6061+5%Tib2
3	Al6061+7.5%Tib2
4	Al6061+10%Tib2

Aluminium

Aluminum powder of 50μm size are mixed with Tib4 and aluminum powder and tib4 and graphite mixed in above given table powders areprepared.

Graphite

Graphite, archaically referred to as plumbago, is a crystalline form of the element carbon with its atoms arranged in a hexagonal structure. It occurs naturally in this form and is the most stable form of carbon under standard conditions.

Titanium diboride

Titanium diboride is an extremely hard ceramic which has excellent heat conductivity, oxidation stability and wear resistance. TiB_2 is also a reasonable electrical conductor, so it can be used as a cathode material in aluminium smelting and can be shaped by electrical discharge machining.

Powders after mixing:

Hardness test:

Vickers hardness studies were carried out for the investigated materials usingMicro Vickers micro hardness tester (micro Vickers hardness tester, Model: LV 700) with 0.5kg load. The indentation time for the hardness measurement was 10 seconds.Averages of six readings were taken for each hardness value.

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Heat Treatment:

The pellets are then inserted in muffle furnace and temperature is gradually in steps until the temperature raise to 600˚C and pellets were maintained at this temperature for 4 hours approximately. The muffle furnace is switched off and pellets are allowed to cool in the furnace itself for 48hours.

Muffle Furnance

Wear behavior:

RESULTS AND ANALYSIS

Hardness values for specimen

composition	D1	D2	VHN
Al6061+2.5%Tib2	82.31	82.40	135.20
Al6061+5%Tib2	94.32	94.25	111.09
Al6061+7.5%Tib2	80.15	80.06	157.750
Al6061+10%Tib2	75.96	76.20	174.069

Heat treated hardness at 2 hours:

D1	D2	VHN	Micro VHN
81.75	135.20	142.70	138.957
82.68	111.09	137.50	144.507
80.71	80.01	159.950	158.850
79.71	161.60	176.089	175.679

composition	D1	D2	VHN
Al6061+2.5%Tib2	82.31	82.40	162.20
Al6061+5%Tib2	94.32	94.25	133.09
Al6061+7.5%Tib2	80.15	80.06	187.750

Heat treated hardness at 4 hours:

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Heat treated hardness at 6 hours:

composition	D1	D2	VHN
Al6061+2.5%Tib2	82.31	82.40	249.08
Al6061+5%Tib2	94.32	94.25	204.654
Al6061+7.5%Tib2	80.15	80.06	289.13
Al6061+10%Tib2	75.96	76.20	314.23

Wear at1kgload200mts:

S.No	Material	Initia weight	Finalweight	Lossofweigh t
1	Al6061+2.5%Tib2	11.9337	11.9204	0.0133
2	Al6061+5 Tib2	11.9530	11.9400	0.0130
3	Al6061+7.5%Tib2	11.4536	11.4409	0.0127
4	Al6061+10%Tib2	11.5339	11.5213	0.0126

Wear at1kgload400mts:

S.No	Material	Initial weight	Finalweight	Lossofweigh t
1	Al6061+2.5%Tib2	11.9337	11.9204	0.0133
2	Al6061+5%Tib2	11.9530	11.9400	0.0130
3	Al6061+7.5%Tib2	11.4536	11.4409	0.0127
4	Al6061+10%Tib2	11.5339	11.5213	0.0126

CONCLUSION AND FUTURE SCOPE:

By using powder metallurgy technique hybrid composites were fabricated successfully.All the composites were exhibits higher hardness than base material.hybrid composites the preference of graphite in hybrid composites will lose the strength because of soft and having much inability.

By using software based electro chemical weld tester system was used to carry out potential dynamic polarization tests conducted.

All the composites were shown better corrosive resistive than the base material.

All the hybrid composites were good corrosive resistive than non-hybrid composites because of graphite and Tib4 were forums a layer of protection to oxygen reaction.

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