Fabrication and Testing of Al6061 B4C using Powder Metallurgy

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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-increasing demandof modern-day technology, composites are most promising materials of recent interest. The present research work involves the study of Al 6061- B_4c composite through powder metallurgy. This method involvesformation of reinforcements within the matrix by the chemical reaction of two or more compounds which also produces some changes in the matrix material within the vicinity.

Boron carbide (B_4c) was the reinforcements in the matrix of Al 6061 {Al 97%-B_{4c} 3%, Al 94%- B_4c 6% and Al 91%- B_4c 9%} alloy which can be suitable for space, aircraft and automotive components at elevated temperatures. The mechanical properties in terms of hardness and impact test were carried out. The sampleof Al 6061 alloy was also casted and tested for comparison.

KEYWORDS: Powder metallurgy technique,Micro hardness, Micro structure, Wear resistance, FESEM

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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 analysisdiscussed in the abstract. Section 5we have given the conclusion and future scope 6 It includes References.

OBJECTIVES

Titanium Diboride(B4C) 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. B4C 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. B4C 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-6061alloy-based composites by using B4C case reinforcement and Al6061-B4C-Gr study the mechanical properties and deformation behavior of these resultantcomposites.

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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.

a.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.

b. 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.

c.Sintering:

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 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, this leaves more microscopic gaps than the full liquefaction caused by melting would.

EXPERIMENTAL WORK:

Composition:

S.no	Material
1	Al6061+4%B4C
2	Al6061+8%B4C
3	Al6061+12% B4C
4	Al6061+16% B4C

Aluminium

Titanium diboride

Graphite

Aluminum powder of 50μm size are mixed with B4C and aluminum powder and B4C and graphite mixed in above given table powders areprepared.

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.

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:

D1	D2	VHN	Micro VHN
67	76	216	212.5
86	78	236	240.5
76	79	267	261.5
82	87	282	278.5

Wear behavior:

RESULTS AND ANALYSIS

Hardness values for specimen:

composition	D1	D2	VHN
Al6061+4%B4C	78	83	209
Al6061+8% B4C	89	86	245
Al6061+12% B4C	76	78	256
Al6061+16% B4C	89	96	275

Heat treatment values of specimens:

composition	D1	D2	VHN
Al6061+4% B4C	87	87	303
Al6061+8% B4C	78	87	325
Al6061+12% B4C	89	79	365
Al6061+16% B4C	98	79	378

At Water:

TRAIL-1

composition	D1	D2	VHN
Al6061+4%B4C	86	86	245
Al6061+8% B4C	68	79	267
Al6061+12% B4C	77	79	278
Al6061+16% B4C	79	96	298

composition	D1	D2	VHN
Al6061+2.5%Tib2	82	82	227.0
Al6061+5%Tib2	94	94	186.3
Al6061+7.5%Tib2	80	80	262.8
Al6061+10%Tib2	75	76	285.6

TRAIL- 2

D1	D2	VHN	Micro VHN
87	86	256	250.5
68	86	276	271.5
89	85	289	283.5
96	95	304	301

At Ice:

TRAIL-1

TRAIL-2

D1	D2	VHN	Micro VHN
87	68	309	306
68	79	356	340.5
89	79	363	364
96	79	382	380

WEAR:

At Wear:

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Material	Initialweigh t	Finalweight	Lossof weight
Al6061+4% B4C	11.949	11.9418	0.0072
Al6061+8% B4C	11.968	11.9609	0.0071
Al6061+12% B4C	11.468	11.4611	0.0069
Al6061+16% B4C	11.548	11.5412	0.0068

Wear at1kgload200mts:

Material	Initialweight	Final weight	Lossofweigh t
Al6061+4 % B4C	11.9418	11.9350	0.0068
Al6061+8 % B4C	11.9609	11.9542	0.0067
Al6061+7. 12% B4C	11.4611	11.4546	0.0065
Al6061+16 % B4C	11.5412	11.5348	0.0064

Wear at1kgload400 mts:

Material	Initialweigh t	Final weight	Lossofweigh t
Al6061+4% B4C	11.9337	11.9204	0.0133
Al6061+8% B4C	11.9530	11.9400	0.0130
Al6061+12% B4C	11.4536	11.4409	0.0127
Al6061+16% B4C	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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