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Al 6061-Basalt and Zirconia Hybrid Composite

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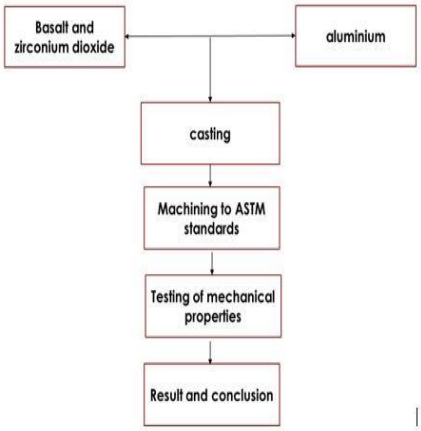
***Abstract:*-- The present work mainly investigates the wear behavioural properties of Al6061 / Basalt / ZrO2 Hybrid Metal Matrix Composites. Al6061 / Basalt / Zr02 Hybrid MMCs containing five different wt% (1, 4, 6, 8, 10%) of Natural Basalt rock powder and keeping 2 wt% of Zirconium oxide constant have been fabricated by using a liquid metallurgy (stir casting) method. The dry sliding wear tests were performed using a Pin-on disc wear testing machine on both composites and a matrix alloys over a different load range, sliding velocity of 1.66m/s and for various sliding distance of 1-6km. Further it was observed from the experimental results that the specific wear rate**

Key Words- Aluminium MMCs, Basalt, ZrO_2, Dry sliding wear, wear resistance.

INTRODUCTION

Composites are one of the most Advanced & Adaptable Engineering Materials. Composite are heterogeneous in nature. Composite material is composed of two or more distinct phases (matrix phase and dispersed phase) and having bulk properties significantly different from those of any of the constituents. The matrix may be me metallic, ceramic or polymeric in origin.

METHODOLOGY



BASALT ROCK POWDER :

Basalt a name derived from the Latin for 'very hard stone', basalt is indeed a very hard, black igneous rock found all over Earth and our solar system. It most commonly forms as an extrusive rock, such as a lava flow, but can also form in small intrusive bodies, such as an igneous layers or a thin sill. The basalt powder contains various properties as tabulated in Table-1.

PETROLOGICAL AND CHEMICAL ROCK TESTING REPORT.

Sl. No.	Rock Properties	Basalt Sample
1.	Colour	Ash grey, at places little white
2.	Texture	Equigranular
3.	Grain size	Fine
4.	Mineral Composites	SiO2,Zeolite minerals
5.	Specific gravity	Medium to High (2.5-3.0 gr/cc)
6.	Mode of formation	Volcanic rocks
7.	Crushing Strength	103 KN
8.	Water absorption	0.08%
9.	Chemical test	No reaction
10.	Occurrence	Volcanic lava flows
11.	Special Properties	Low porosity, High crushing strength
12.	Uses/Importance	Good building stone, Road metal, Concrete aggregates

Table-1 Petrological and Chemical Rock Test Report.

PROPERTIES OF BASALT FIBER:

It has excellent thermal properties to that of glass fibers.
It has tensile strength of 4.84 Gpa.
It has high elastic modulus.

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It has elongation at break is 3.15%.
It is safe and abundant.
It has better corrosion resistance.
It is extremely hard & has hardness values between

5 to 9 on Mohr's scale, which results in better abrasion property.
Completely inert with no environmental risks.
Good sound absorbing properties.
Good moisture regaining capacity.

ZIRCON

Zirconia, mainly consisting of ZrO2, has the highest mechanical strength and fracture toughness at room temperature of all major fine ceramics. It is used to make cutting blades, scissors and knives. It is also used for pump parts due to its superior surface smoothness. The main use of zirconia is in the production of hard ceramics, such as in dentistry (see below),[1][2] with other uses including as a protective coating on particles of titanium dioxide pigments,[3] as a refractory material, in insulation, abrasives and enamels. Stabilized zirconia is used in oxygen sensors and fuel cell membranes because it has the ability to allow oxygen ions to move freely through the crystal structure at high temperatures. This high ionic conductivity (and a low electronic conductivity) makes it one of the most useful electro ceramics.[3] Zirconium dioxide is also used as the solid electrolyte in electro chromic devices [Table-2].

Sl.No.	Test Results	Unit	Actual results
1.	Apperance	Visual	White to off white creamish powder
2.	Assay	%	99.91
3.	ZrO2 +HFo2	%	99.91
4.	Solubale Silica	%	0.03
5.	Fe	%	0.004
6.	Na	%	0.005
7.	CaO +MgO	%	0.006
8.	Moisture	%	0.031

Table-2 Analysis of Zirconium Oxide

PREPARTION PROCESS

Metal Matrix Composites (MMC) are considered as group of advanced materials which represent low density, high tensile strength, high modulus of elasticity, low coefficient of thermal expansion and high wear resistance. These characteristics could not be achieved together in the monolithic materials like alloys.The fabrication methods used for MMC's are powder metallurgy, stir casting, squeeze casting etc. Manufacturing of aluminium alloy based composite materials via stir casting is one of the prominent and ecological route for development and processing of metal matrix composites.

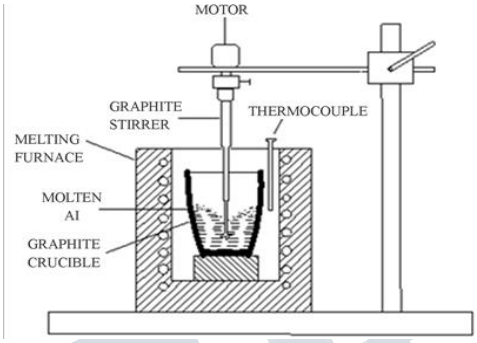

Fig-1 Stir Casting Process

The procedure followed to produce AlMMCs by stir casting Fig-1 is briefly listed below. Initially commercially available pure Al6061, naturally available Basalt, and Zirconium dioxide (ZrO2) was chosen as starting materials. A measured quantity of Al6061 in the form of ingots were taken and charged in to the crucible that was inserted in an electrical furnace. The charged Al6061 was left in the crucible, which is maintained at 800□C for about 2 hours until the Al6061 in the form of ingots turn in to molten metal. The molten melt was degassed by using degassing tablets to remove the gasses present in the melt and scum powder used for removing slag and flux. For stirring the melt a motor with capacity of 1HP was used above the crucible with a facility to move the rotor along with the stirrer, the stirrer used in this work is ceramic coated steel impeller, which was stirred at 500 rpm. Until the vortex is formed in the molten metal. Weighed quantity of Basalt, which is preheated at 800 C to remove the moisture were introduced in to the melt. Along with these Basalt a known quantity of ZrO2 is added to the melt (2%). □ After addition of Basalt and ZrO2 particles the molten alloy was stirred for about 3-5 minutes. The temperature was constantly maintained at 820□C throughout the course of stirring process. After the complete reinforcement of Basalt and ZrO2 in to the Al6061 matrix, molten metal was poured in to the cast iron mould which is preheated to 250□C. The molten metal was allowed to solidify by natural cooling for duration of 2-3 hours. Finally composites of 12mm diameter and 190mm long were produced and the castings were removed from the dies after complete solidification. The above said procedure was repeated to cast composites with different weight percentage of Basalt (1,2,4,6,8, and 10%) and keeping ZrO2 content constant (2%).

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CONCLUSION

It is evident that there has been no attempt to develop Al6061+Basalt particulate reinforced composites using stir casting method. Hence the present research is aimed at developing natural Basalt particulate composites by stir casting method an effort has been made to prepare the natural basalt aluminium composite and to compare with that of basalt fiber aluminium composite.

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