MECHANICAL AND CHARACTERISTICS BEHAVIOUR OF IRON AND ALUMINIUM BILLETS WITH ADDITION OF TITANIUM

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Abstract - Metal-matrix composites (MMCs) are a class of materials with potential for a wide variety of structural and thermal management applications. They are nonflammable, do not outgas in a vacuum, and suffer minimal attack by organic fluids, such as fuels and solvents. This Article presents an overview of the status of MMCs, and provides information on physical and mechanical properties, processing methods, distinctive features, and various types of continuously and discontinuously reinforced aluminum, magnesium, titanium, copper, super alloy, and intermetallic-matrix composites. It further discusses the property prediction and processing methods for MMCs.Titanium alloys are used as matrix material in fabricating MMCs due to their good strength at elevated temperatures and excellent corrosion resistance.

Key Words: **Titanium, Aluminium, Iron and Stir casting.**

1. INTRODUCTION

Composites are nothing but combination of two or more materials to improve mechanical, thermal and corrosion. Composite materials having a huge advantages like light in weight, easy availability, higher strength, higher stiffness, higher hardness, Corrosive resistance better properties at elevated temperatures etc. In MCC (Metal Matrix Composites) one element should be metal or alloy it occupy the maximum portion in the composite, and then it is called as base metal matrix. Composite on other hand small portion of material is added to the basic metal matrix is called reinforced material.

1.1 Stir casting

Among the variety of manufacturing processes available for discontinuous metal matrix composites, stir casting is generally accepted as a particularly promising route, currently practiced commercially. Its advantages lie in its simplicity, flexibility and applicability to large quantity production with cost advantage. The major problem of this process is to obtain sufficient wetting of particle by liquid metal and to get a homogenous dispersion of the particulates. The present review is on the method employed in stir casting such as, how the base metal is melted, at what temperature and state it is to be maintained, what conditions the particulates are added and how the stirring time and stirring speed affect the final composite material. The effect of stirrer design and feeding mechanism has also been discussed. The variation in the type of mixing the particulates into the metal matrix has also been dealt with in the paper. In the introductory part the stir casting methodology with a diagram has been laid out to give an overview of the overall process of casting of metal matrix composites. The limitations of the process are also listed in the paper.

2. Materials and method

2.1 Iron

Iron is a chemical element with symbol Fe and atomic number 26. It is a metal that belongs to the first transition series and group 8 of the periodic table. It is by mass the most common element on Earth, forming much of Earth's outer and inner core. It is the fourth most common element in the Earth's crust.

Table -1: Properties of Iron

Atomic Number (Z)	26
Phase at STP	Solid
Melting point	1811 K(1538°C, 2800°F)
Boiling Point	3134 K (2862 °C, 5182 °F)
Heat of fusion	13.81 kJ/mol
Heat of vaporization	13.81 kJ/mol
Molar heat capacity	25.10 J/(mol·K)

2.2 Aluminium

Aluminium is remarkable for its low density and its ability to resist corrosion through the phenomenon of passivation. Aluminium and its alloys are vital to the aerospace industry and important in transportation and building industries, such as building facades and window frames. The oxides and sulfates are the most useful compounds of aluminium. Despite its prevalence in the environment, no known form of life uses aluminium salts metabolically, but aluminium is well tolerated by plants and animal

2.3 Titanium

Titanium was discovered in Cornwall, Great Britain, by William Gregor in 1791 and was named by Martin Heinrich Klaproth after the Titans of Greek mythology. The element occurs within a number of mineral deposits, principally rutile and ilmenite, which are widely distributed in the Earth's crust and lithosphere; it is found in almost all living things, as well as bodies of water, rocks, and soils. The metal is extracted from its principal mineral ores by the Kroll and Hunter processes. The most common compound, titanium dioxide, is a popular photo catalyst and is used in the manufacture of white pigments. Other compounds include titanium tetrachloride ($TiCl_4$), a

3. Methodology

For performing the experiment and testing of alloy the following equipment's are used in Weighing mach, Stir casting se ,Tensile and Vickers Tester, Scanning electron microscope (SEM),Energy Dispersive X-Ray Analysis (EDX) and X-Ray Diffraction (XRD)

3.1 Compositions and Casting

Casting is a manufacturing process in which a liquid material is usually poured into a mold, which contains a hollow cavity of the desired shape, and then allowed to solidify. The solidified part is also known as a casting, which is ejected or broken out of the mold to complete the process. Casting materials are usually metals or various time setting materials that cure after mixing two or more components together; examples are epoxy, concrete, plaster and clay. Casting is most often used for making complex shapes that would be otherwise difficult or uneconomical to make by other methods. Heavy equipment like machine tool beds, ships' propellers, etc. can be cast easily in the required size, rather than fabricating by joining several small pieces.

3.2 Experimental Procedure

The process of casting starts with placing empty crucible in the furnace. The heater temperature is then gradually increased up to 850°C.Metals are cleaned to remove dust particles, weighed and charged in the crucible for melting., Required quantities of reinforcement powder and magnesium powder are weighed on the weighing machine. Reinforcements are heated for 45 minutes at a temperature of 500°C.After five minutes the scum powder is added which forms a scum layer of impurity on liquid surface which to be removed. Heater temperature is then gradually increased to 850°C.At this heater temperature stirring is started and continued for five minutes. The flow rate of reinforcements measured is 0.5 gram per second. Then molten composite slurry is poured in the metallic mould without giving time for reinforcement to settle down at crucible bottom. Mould is preheated at 500°C temperature for one hour before pouring the molten slurry in the mould. This is necessary to maintain slurry in molten condition throughout the pouring. While pouring the slurry in mould the flow of the slurry is kept uniform to avoid trapping of gas, also distance between crucible and mould plays a vital role in quality of casting.

3.3 Surface Polishing

Surface Polishing is finishing processes for smoothing a work piece's surface using an abrasive and a work wheel or a leather strop. Technically polishing refers to processes that use an abrasive that is glued to the work wheel, while buffing uses a loose abrasive applied to the work wheel. Polishing is a more aggressive process while buffing is less harsh, which leads to a smoother, brighter finish.[1] A common misconception is that a polished surface has a mirror bright finish, however most mirror bright finishes are actually buffed. Polishing is often used to enhance the appearance of an item, prevent contamination of instruments, remove oxidation, create a reflective surface, or prevent corrosion in pipes. In metallographic and metallurgy, polishing is used to create a flat, defect-free surface for examination of a metal's microstructure under a microscope. Silicon-based polishing pads or a diamond solution can be used in the polishing process. Polishing stainless steel can also increase the sanitary benefits of it.

4. Testing and Analysis

4.1 Scanning electron microscope (SEM)

The scanning electron microscope (SEM) is one of the most versatile instruments available for the examination and analysis of the microstructure morphology and chemical composition characterizations. It is necessary to know the basic principles of light optics in order to understand the fundamentals of electron microscopy. The unaided eye can discriminate objects subtending about 1/60° visual angle, corresponding to a resolution of ~0.1 mm (at the optimum viewing distance of 25 cm). Optical microscopy has the limit of resolution of ~2,000 Å by enlarging the visual angle through optical lens. Light microscopy has been, and continues to be, of great importance to scientific research. Since the discovery that electrons can be deflected by the magnetic field in numerous experiments in the 1890s, electron microscopy has been developed by replacing the light source.

Fig 1 Scanning Electron Microscope

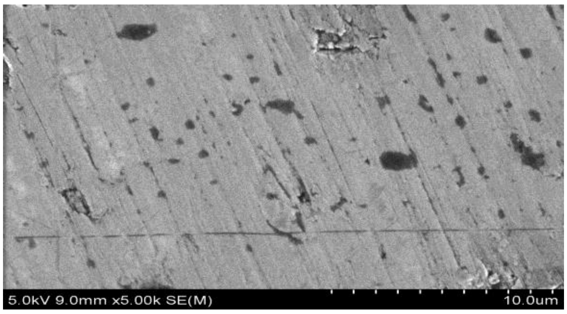

Fig 2 SEM Image of Sample1

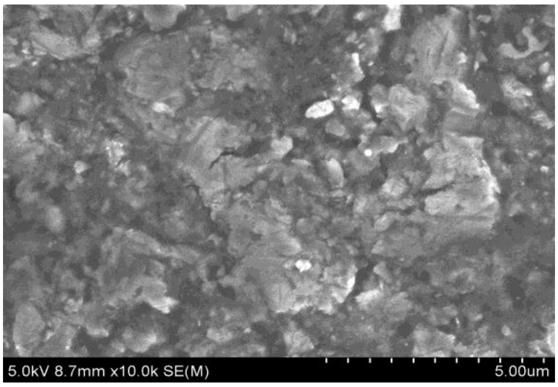

Fig 3 SEM Image of Sample2

4.2 Energy Dispersive X-Ray Analysis (EDX)

Energy-dispersive X-ray spectroscopy (EDS, EDX, EDXS or XEDS), sometimes called energy dispersive X-ray analysis (EDXA) or energy dispersive X-ray microanalysis (EDXMA), is an analytical technique used for the elemental analysis or chemical characterization of a sample. It relies on an interaction of some source of X-ray excitation and a sample. Its characterization capabilities are due in large part to the fundamental principle that each element has a unique atomic structure.

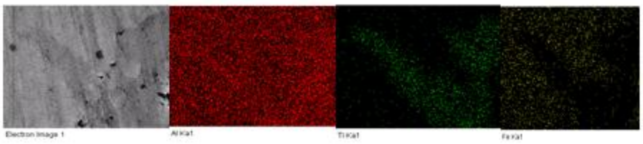

Fig -4 EDAX Image of sample 1

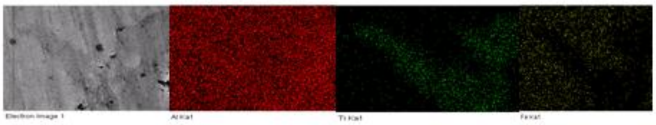

Fig -5 EDAX Image of sample 2

Element	App. Conc	Intensity Conrn	Weight %	Weight % Sigma	Atomic %
AIK	17.1	0.9943	65.78	1.25	79.56
Tik	1.10	0.9017	4.64	0.58	3.16
Fek	6.99	0.8986	29.58	1.26	17.28
Totals			100		

Table-2 EDX Test Result Sample 1

Element	App. Conc	Intensity Conrn	Weight %	Weight % Sigma	Atomic %
AIK	45.72	0.9470	62.22	0.71	77.31
Tik	0.08	0.9129	0.11	0.20	0.08
Fek	26.55	0.9080	37.67	0.71	22.62
Totals			100		

Table-3 EDX Test Result Sample 2

4.3 X-Ray Powder Diffraction Analysis (XRD)

X-Ray Diffraction (XRD) Analysis, is an analytical technique designed to provide more in-depth information about crystalline compounds, including identification and quantification of the morphology of crystalline phases. . This is a useful tool when trying to positively identify a contaminant or corrosion product, and for identification of foreign phases for purity analyses of crystalline powders.

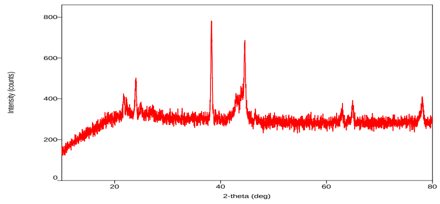

Fig 6 XRD Graph of Sample 1

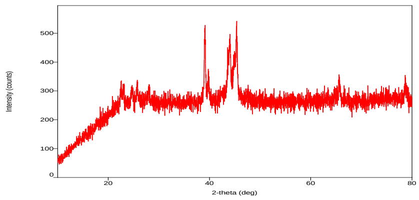

Fig 7 XRD Graph of Sample 2

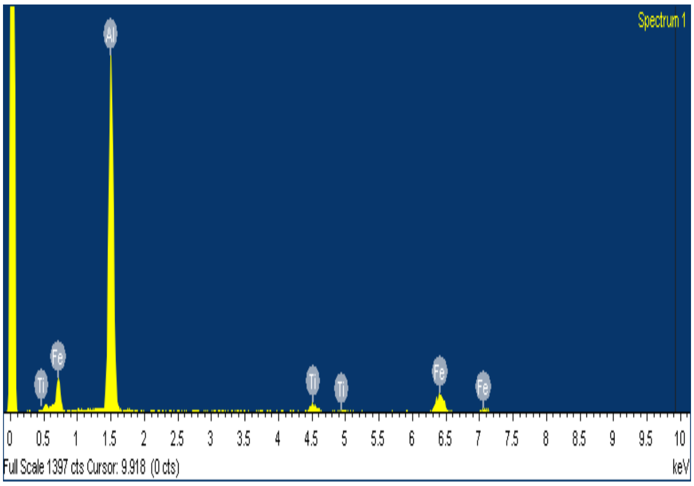

Fig 8 EDAX Image of Sample1

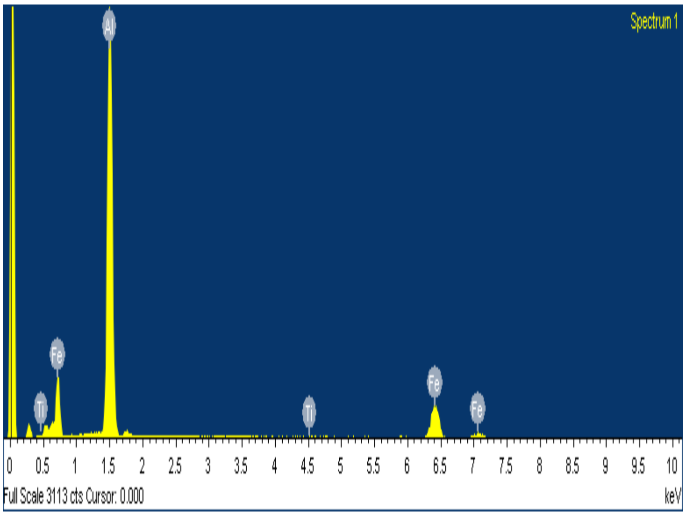

Fig 9 EDAX Image of Sample 2

4.4 Vickers hardness Test

The Vickers hardness test was developed in 1921 by Robert L. Smith and George E. Sandland at Vickers Ltd as an alternative to the Brinell method to measure the hardness of materials. The Vickers test is often easier to use than other hardness tests since the required calculations are independent of the size of the indenter, and the indenter can be used for all materials irrespective of hardness. The basic principle, as with all common measures of hardness, is to observe a material's ability to resist plastic deformation from a standard source.

Lakshmi Vacuum Heat Treaters P Ltd

Certificate of Conformance

Customer: Tharanidharan
Certificate No: 4011
Reference No: 5069
Date: 10-03-2020

Material Grade: MIXED ALLOY

Test Details

Description /Part No	Quantity	Test Results	Remark
MIXED ALLOY	1	111 HV	OK

Conclusion:

Fig 10 Hardness Test Sample 1

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Fig 11 Hardness Test Sample 2

4.5 Ultimate tensile strength

Tensile strength, maximum load that a material can support without fracture when being stretched, divided by the original cross-sectional area of the material. Tensile strengths have dimensions of force per unit area and in the English system of measurement are commonly expressed in units of pounds per square inch, often abbreviated to psi.

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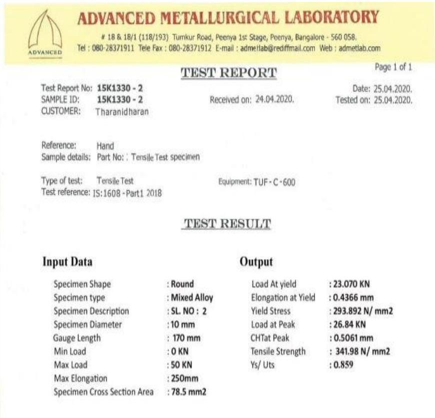
When stresses less than the tensile strength are removed, a material returns either completely or partially to its original shape and size.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TEST REPORT

Test Report No: 15K1330 - 2 Date: 25.04.2020.
SAMPLE ID: 15K1330 - 2 Received on: 24.04.2020. Tested on: 25.04.2020.
CUSTOMER: Tharanidharan

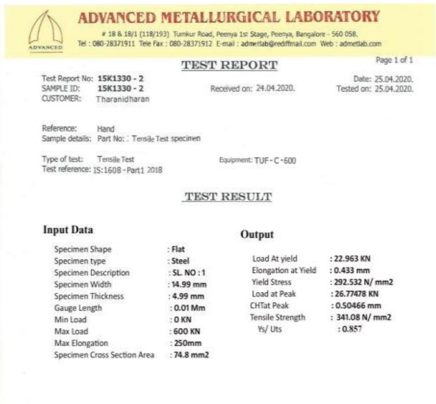
Reference: Hand
Sample details: Part No: : Tensile Test specimen

Type of test: Tensile Test Equipment: TUF - C - 600
Test reference: IS:1608 - Part1 2018

TEST RESULT

Input Data		Output	
Specimen Shape	: Round	Load At yield	: 23.070 KN
Specimen type	: Mixed Alloy	Elongation at Yield	: 0.4366 mm
Specimen Description	: SL. NO : 2	Yield Stress	: 293.892 N/ mm2
Specimen Diameter	: 10 mm	Load at Peak	: 26.84 KN
Gauge Length	: 170 mm	CHTat Peak	: 0.5061 mm
Min Load	: 0 KN	Tensile Strength	: 341.98 N/ mm2
Max Load	: 50 KN	Ys/ Uts	: 0.859
Max Elongation	: 250mm		
Specimen Cross Section Area	: 78.5 mm2		

Fig 12 Tensile Test Sample 1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Reference: Hand
Sample details: Part No: : Tensile Test specimen

Type of test: Tensile Test Equipment: TUF - C - 600
Test reference: IS:1608 - Part1 2018

TEST RESULT

Input Data		Output	
Specimen Shape	: Flat		
Specimen type	: Steel	Load At yield	: 22.963 KN
Specimen Description	: SL. NO : 1	Elongation at Yield	: 0.433 mm
Specimen Width	: 14.99 mm	Yield Stress	: 292.532 N/ mm2
Specimen Thickness	: 4.99 mm	Load at Peak	: 26.77478 KN
Gauge Length	: 0.01 Mm	CHTat Peak	: 0.50466 mm
Min Load	: 0 KN	Tensile Strength	: 341.08 N/ mm2
Max Load	: 600 KN	Ys/ Uts	: 0.857
Max Elongation	: 250mm		
Specimen Cross Section Area	: 74.8 mm2		

Fig 13 Tensile Test Sample 2

5. Conclusion

As a result, they are found where improved properties and performance can justify the added cost. Today these applications are found most often in aircraft components, space systems and automotive, it is very important to increase the payload capacity of the aircraft by enhancing the Reliability. The scope of applications will certainly increase as manufacturing costs are reduced through continual improvement initiatives.

6. References

[1] Ranjit Bauri, Devinder Yadav, in Metal Matrix Composites by Friction Stir Processing, 2018
[2] K.O. Cooke, in Intermetallic Matrix Composites, 2018
[3] M. Haghshenas, in Reference Module in Materials Science and Materials Engineering, 2016
[4] Materials science and Engineering, an introduction. William D. Callister Jr, 7th Ed, Wiley and sons publishing.