PREPARATION AND CHARACTERIZATION OF ALUMINIUM FOAM PREPARED THROUGH MELT ROUTE METHOD

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Abstract - The intend of this work is to produce aluminium foam from aluminium (LM0) for the application of light weight structural components. Melt route method is the technique adapted. Here 2kgs of aluminium (LM0) is melted to its melting temperature (750°C) and 200g of preheated dolomite CaMg $(CO_3)_2$ was mixed to the molten metal and stirred for 30 – 90 seconds at 1200 rpm approximately. Gas bubbles produced in the liquid aluminium (LM0) form cells and pores. The mixer was solidified in to the room temperature, to get the final product as aluminium foam. Mechanical properties such as tensile strength and hardness were conducted on the aluminium foam following the standards.

Keywords: Aluminium (LM0), Dolomite, Melt route method, Tensile strength.

1. Introduction

"*The foam is characterized as a uniform scattering of gas rises in a fluid, isolated by thin film of fluid making a pore or cell*".

In globalization there is an intense struggle between the manufacturing sectors for choosing a metal for economical production of the component [1-4]. In current scenario, the foam materials and composite materials are used in industries [5-8]. Due to their structure foams behave differently in testing when compared to conventional metal. The behavior of aluminium foams depends on several parameters such as: tensile strength, shear strength, impact strength, hardness strength and wear property [9-16]. Machinability of metals has received significant attention because of high tool wear connected with machining [17-27].

Banhart [3] reviewed about the introduction of aluminium foams, its properties, applications and its various types of its manufacturing methods. Simancik et al., [5] had done a work on preparation of Aluminium foam - a new light weight structural material by melt route method. Duarte et al., [6] had done a work on aluminium Alloy Foams: production and properties. Mukherjee [7] reviewed about the introduction of aluminium foams, its properties, applications and its various types of its manufacturing methods. Surace et al., [9] said on a work on investigation and comparison of the different manufacturing techniques of the aluminium foam. Vivekananthan and Senthamarai [10] said on a work on experimental evaluation of aluminium fly ash composite material to increase the mechanical and wear behavior by stir casting method. Hussain and Suffin [11] investigated the microstructure and mechanical behavior of the foam produced by sintering dissolution process.

Initially, 2kgs of LM0 grade aluminium was melted in the furnace. The melting temperature of aluminium was about 750°C. After attaining the melting point the preheated foaming agent was added in the ratio of 1:10 to the molten aluminum and the aluminium foam is prepared by using stir casting furnace.

2. Experimental Procedure

2.1. Melt Route Method

- Aluminium bar is melted to its melting temperature (750°C).
- The molten metal is stirred for several minutes.
- The dolomite powder was pre heated up to 200 °C and it is mixed with the molten metal.
- The foaming agent attains the decomposition temperature (660°C) the carbon dioxide (CO_2) which is present in it will be emitted as CO_2 gas.
- The uniform gas bubbles are formed by stirring. This makes the porosity inside the molten aluminium; finally the created aluminium foam is solidified into molten metal.

2.2. Reaction of dolomite:

When the dolomite attains the decomposition temperature the carbon dioxide (CO_2) which is present in it will be emitted in the form of CO_2 gas. So the uniform dispersion of gas bubbles is formed by stirring it at 1200rpm. This makes the porosity inside the molten aluminium so that the foam is created.

$$CaMg(CO_3)_2 = CaCO_3 + MgO + CO_2 \quad (1)$$
$$CaCO_3 = CaO + CO_2 \quad (2)$$

Table 1: Preheated foaming agent (Dolomite)

Sl. No.	Weight of Al (Kg)	Raise of temp (°C)	Drop of temp (°C)	Weight of foaming agent (Dolomite) (Grams)	Stirring time (Sec)	Stirring speed (rpm)	Solidification
1	2	750	680	200	70	1200	Room temperature

Figure 1: Stir Casting Set up

3. Results and Discussions

3.1. Tensile Test

A tensile test, also known as tension test, is probably the most fundamental type of mechanical test you can perform on material. Tensile tests are simple, relatively inexpensive, and fully standardized. By pulling on something, you will very quickly determine how the material will react to forces being applied in tension. As the material is being pulled, you will find its strength along with how much it will elongate.

3.1.1. Observation:

Initial Length of the specimen (L_i) = 220mm
Initial Diameter of the specimen (D_i) = 12mm
Final Length of the specimen (L_f) = 222mm
Final Diameter of the specimen (D_f) = 10mm

Table 2: Tensile test on foam

Sl. No.	Type of Load	Load		Change in Length	Stress (σ) N/ mm²	Strain (Є)
		KN	N			
1.	Yield Load	0.5	500	0.25	4.421	0.001136
2.	Ultimate Load	4.5	4500	15	39.791	0.068
3.	Breaking Point	1.5	1500	16	13.263	0.072

3.2. Rockwell Hardness Test

The Rockwell scale is a hardness scale based on indentation hardness of a material. The Rockwell test determines the hardness by measuring the depth of penetration of an indenter under a large load compared to the penetration made by a preload. There are different scales, denoted by a single letter, that use different loads or indenters. The result is a dimensionless number noted as HRA, where A is the scale letter.

When testing metals, indentation hardness correlates linearly with tensile strength. This important relation permits economically important non-destructive testing of bulk metal deliveries with lightweight, even portable equipment, such as hand-held Rockwell hardness testers

Table 3: Rockwell hardness test on foam

Sl. No.	Material	Size of The Intender (mm)	Total test Force (or) Major load (kgf)	Dial	Scale	Rockwell hardness number (HRC)	Mean Value (HRC)
1.	Al Foam	1.5875	100	Red	B	42	45
2.	Al Foam	1.5875	100	Red	B	48	

3.3. Scanning Electron Microscope (SEM) Analysis

Micro structural characterization studies were conducted on Aluminium foam sample. This is accomplished by using scanning electron microscope. The Foam sample was metallographically polished prior to examination. Characterization is done in etched conditions. Etching was accomplished using Keller's reagent. The SEM micrographs of foam were obtained using the scanning electron microscope. The images were taken in back scattered electron (BSE) mode according to requirement. Microscopic studies to examine the morphology, particle size and micro structure were done by scanning electron microscope (SEM) equipped with an energy dispersive X-ray (EDX) detector. Micrographs are taken at suitable accelerating voltages for the best possible resolution of 300X using the secondary electron imaging.

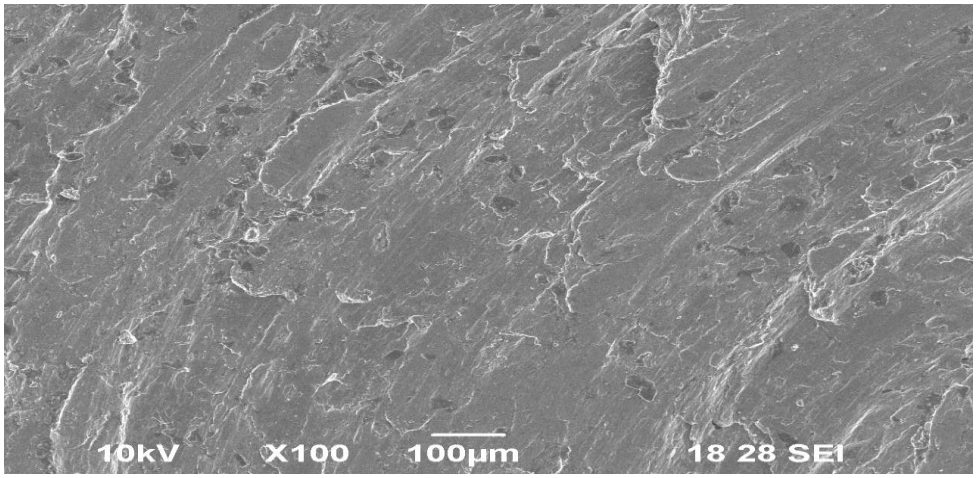

Figure 2: Sample 1

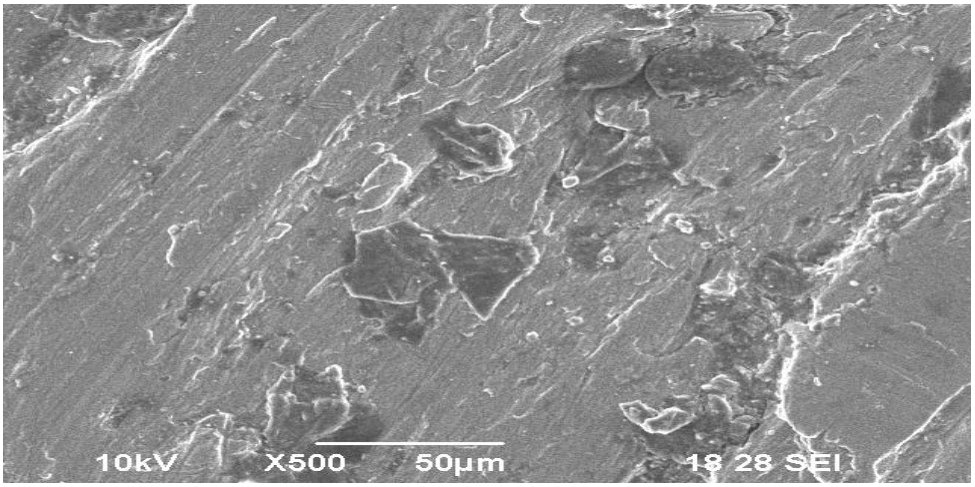

Figure 3: Sample 2

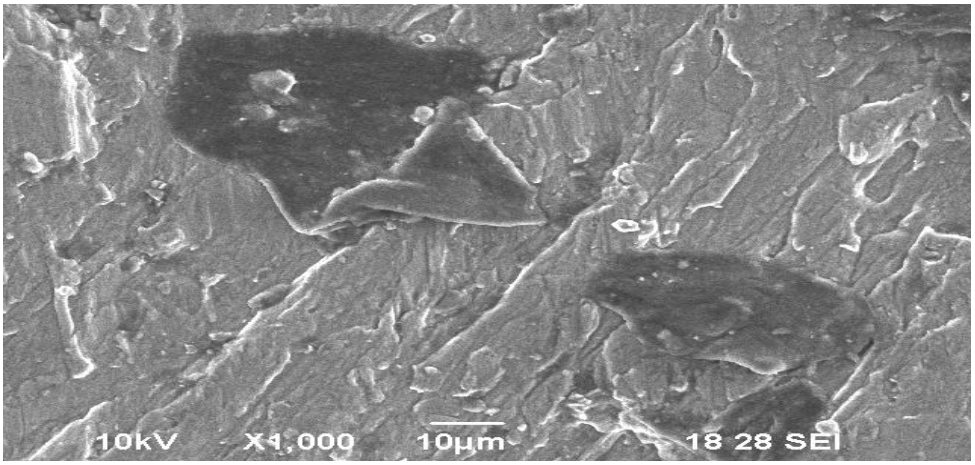

Figure 4: Sample 3

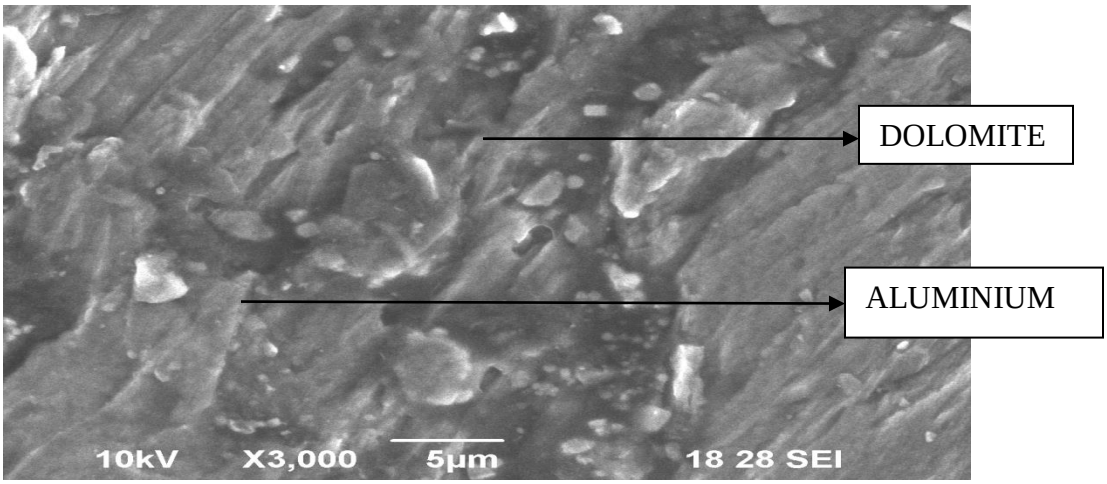

Figure 5: Sample 4

The above figures show the SEM micrograph of aluminum foam samples.

4. Conclusion

Aluminium foam was produced, using dolomite as foaming agent in the ratio of 10:1 by melt route method. The mechanical properties like tensile strength and hardness were tested. The preheated Dolomite-aluminum foam samples have the better porosity and good mechanical properties. In general applications like window, sliding doors, etc were pure Aluminium are used. Aluminium foam can be used as an alternative material for the above applications.

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