EXPERIMENTAL INVESTIGATION OF AL 8011 ALUMINIUM ALLOY REINFORCED WITH SILICON CARBIDE AND BORON CARBIDE

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ABSTRACT

Metal matrix composite (MMC) focuses primarily on improved specific strength, high temperature and wear resistance application. From the collected literature it is found that, metal matrix composite is under serious consideration as potential candidate for Automotive applications. So, the MMC are highly used in automotive and space applications. The mechanical properties like tensile strength, compression strength and hardness can be increased by reinforcing Al 8011 matrix with boron carbide (B_4C) and Silicon Carbide (Sic) particles.

1.INTRODUCTION

The metal matrix composites (MMCs), like all other composites consist of at least two chemically and physically distinct phases, suitably distributed to provide properties not obtainable with either of the individual phases. For much research the term MMCs is often equated with the term light metal matrix composites. Substantial progress in the development of light metal matrix composites has been achieved in recent decades, so that they could be introduced into the most important applications. Aluminum matrix composites (AMCs) are the competent material in the industrial world. Due to its excellent mechanical properties, it is widely used in aerospace, automobiles, marine etc. The aluminum matrix is getting strengthened when it is reinforced with the hard ceramic particles like Sic, Al_2O_3, and B_4C etc.

1.1 OBJECTIVE:

The objective of this research work is to

1. Use stir casting setup facilities to fabricate Aluminium metal matrix composites reinforced with Silicon carbide and Boron carbide.
2. Study the microstructure of the developed composite using scanning electron microscope.
3. Study the hardness, tensile and impact properties of the developed composite

1.2 MATERIALS

The primary reason composite materials (AL8011) are chosen for component is because of weight saving for its relative stiffness and strength. Silicon carbide (Sic) is being used for high temperature materials because they have several characteristic properties, such as high elastic modulus and hardness, excellent thermal and chemical stabilities, low thermal and electrical conductivities, and relatively low thermal expansion coefficients. Boron carbide is an extremely hard ceramic and covalent material used in bulletproof vests, tank armor, engine sabotage powders as well as numerous industrial applications.

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1. METHODOLOGY

Al8011 composites containing silicon carbide and Boron carbide manufactured using the stir casting setup. The manufactured composites were cut and machined for the required dimension to carry out different tests. The mechanical properties such as microhardness, tensile strength, impact strength and flexural strength was studied for the developed composite. Studied the microstructure of the developed composite using scanning electron microscope. At present number of Aluminium Matrix Composites (AMCs) are used in various applications to replace the existing materials. The major advantage of AMCs is highest strength to weight ratio. Aluminium reinforced with silicon carbide and Boron carbide is the mostly used composite material for different applications. The newly fabricated composite material will be very much useful for replacement of existing automobile materials.

SPECIMEN	COMPOSITION
1	(100% Al 8011 + 0% Silicon Carbide +0% Boron Carbide)
2	(97% Al 8011 + 2% Silicon Carbide + 1% Boron Carbide)
3	(97% Al 8011 + 1% Silicon Carbide + 2% Boron Carbide)

2.1 PROCESS CARRIED

- **Casting:** The casting method used in this process is stir casting. The casting was done by adding Aluminium8011, Silicon Carbide and Boron Carbide.

- **Machining:** Machining is any of various processes in which a piece of raw material is cut into a desired final shape and size by a controlled material-removal process. The various machining processes used are cutting and facing.

- **Metal Cutting:** Metal cutting or machining is the process of by removing unwanted material from a block of metal in the form of chips. Cutting processes work by causing fracture of the material that is processed. Usually, the portion that is fractured away is in small sized pieces, called chips. Common cutting processes include sawing, shaping (or planning), broaching, drilling, grinding, turning and milling. Although the actual machines, tools and processes for cutting look very different from each other, the basic mechanism for causing the fracture can be understood by just a simple model called for orthogonal cutting.

- **Facing**:. A user will have the option to hand feed the machine while facing, or use the power feed option. For a smoother surface, using the power feed option is optimal due to a constant feed rate. Facing will take the work piece down to its finished length very accurately. Depending on how much material needs to be taken off, a machinist can choose to take roughing or finishing cuts.

2. HARDNESS TEST

The Vickers hardness test method, also referred to as a microhardness test method, is mostly used for small parts, thin sections, or case depth work.

sample I.D	Hardness Values, Hardness Vickers @ 0.5 Kgf; Dwell : 10Sec		
	Zone-1	Zone-2	Zone-3
(97% Al 8011 + 1% Silicon Carbide + 2% Boron Carbide)	38.7	35.1	37.0
Base metal (100% Al 8011 + 0% Silicon Carbide +0% Boron Carbide)	34.1	32.7	35.5
(97% Al 8011 + 2% Silicon Carbide + 1% Boron Carbide)	40.2	41.7	43.5

4. IMPACT STUDIES

The impact test is a method for evaluating the toughness, impact strength and notch sensitivity of engineering materials.

sample I.D	Impact Values, Joules		
	Zone-1	Zone-2	Zone-3
(97% Al 8011 + 1% Silicon Carbide + 2% Boron Carbide)	33.0	31.0	30.8
Base metal (100% Al 8011 + 0% Silicon Carbide +0% Boron Carbide)	34.0	39.0	39.5
(97% Al 8011 + 2% Silicon Carbide + 1% Boron Carbide)	26.0	29.0	32.5

5. TENSILE STUDIES

A tensile test can be performed on a Materials Testing instrument or Texture Analyser which are force measuring instruments that perform compression and tensile tests and provide an objective quantification of compressive or tensile strength.

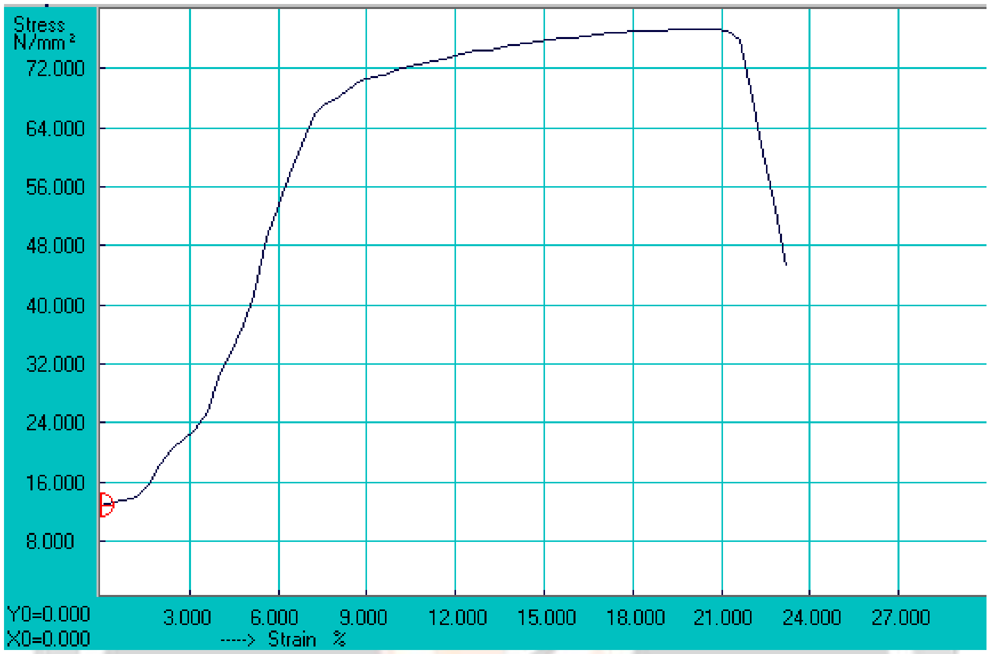
Fig-1 Tesile test apparatus

5.1 TENSILE TEST OF SPECIMEN 1

The Tensile process of specimen 1 contains (100% AL 8011+0% SILICON CARBIDE+0% BORON CARBIDE)

DISPLACEMENT IN MM	LOAD IN KN	DISPLACEMENT IN MM	LOAD IN KN
0	0.495	3.9	2.935
0.1	0.51	4.0	2.94
0.2	0.525	4.1	2.945
0.3	0.54	4.2	2.955
0.4	0.605	4.3	2.96
0.5	0.705	4.4	2.965
0.6	0.79	4.5	2.97
0.7	0.84	4.6	2.975
0.8	0.89	4.7	2.975
0.9	0.98	4.8	2.985
1.0	1.16	4.9	2.985
1.1	1.29		
1.2	1.44		
1.3	1.59		
1.4	1.895		
1.5	2.065		
1.6	2.225		
1.7	2.385		
1.8	2.54		
1.9	2.59		
2.0	2.625		
2.1	2.665		
2.2	2.71		
2.3	2.73		
2.4	2.745		
2.5	2.765		
2.6	2.79		
2.7	2.8		
2.8	2.815		
2.9	2.825		
3.0	2.845		
3.1	2.865		
3.2	2.87		
3.3	2.875		
3.4	2.89		
3.5	2.9		
3.6	2.905		
3.7	2.915		
3.8	2.925		

GRAPH-1:



Stress vs Strain

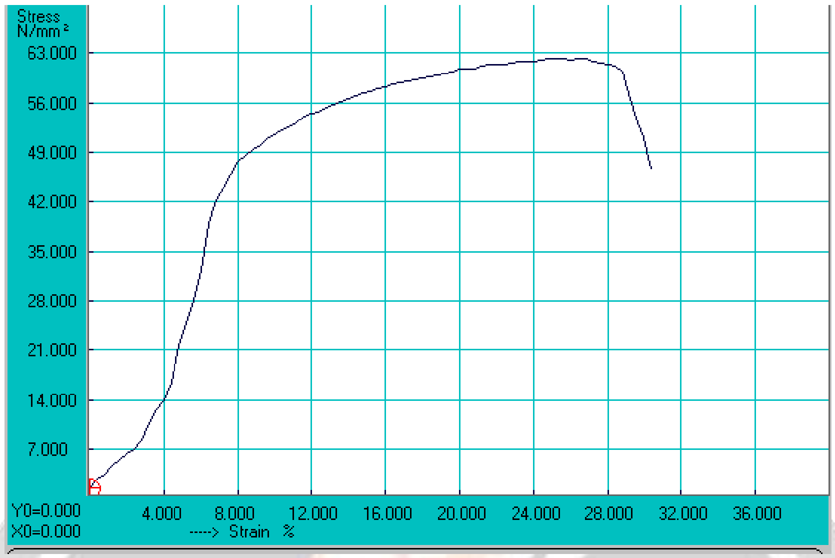
5.2 TENSILE TEST OF SPECIMEN 2

The Tensile process of specimen 2 contains (97% AL 8011+1% SILICON CARBIDE+2% BORON CARBIDE).

Fig-2 Tesile test specimen after the test

DISPLACEMENT IN MM	LOAD IN KN	DISPLACEMENT IN MM	LOAD IN KN
0	0.55	3.9	2.19
0.1	0.105	4.0	2.2
0.2	0.13	4.1	2.215
0.3	0.18	4.2	2.225
0.4	0.21	4.3	2.23
0.5	0.24	4.4	2.24
0.6	0.265	4.5	2.25
0.7	0.315	4.6	2.26
0.8	0.405	4.7	2.265
0.9	0.48	4.8	2.275
1.0	0.53	4.9	2.28
1.1	0.625	5.0	2.295
1.2	0.82	5.1	2.3
1.3	0.94	5.2	2.31
1.4	1.055	5.3	2.32
1.5	1.22	5.4	2.32
1.6	1.475	5.5	2.32
1.7	1.6	5.6	2.32
1.8	1.66	5.7	2.33
1.9	1.735	5.8	2.335
2.0	1.805	5.9	2.34
2.1	1.84	6.0	2.34
2.2	1.865	6.1	2.345
2.3	1.89	6.2	2.35
2.4	1.93	6.3	2.35
2.5	1.95		
2.6	1.97		
2.7	1.99		
2.8	2.015		
2.9	2.04		
3.0	2.055		
3.1	2.07		
3.2	2.09		
3.3	2.11		
3.4	2.125		
3.5	2.135		
3.6	2.155		
3.7	2.17		
3.8	2.18		

GRAPH-2:



Stress vs Strain

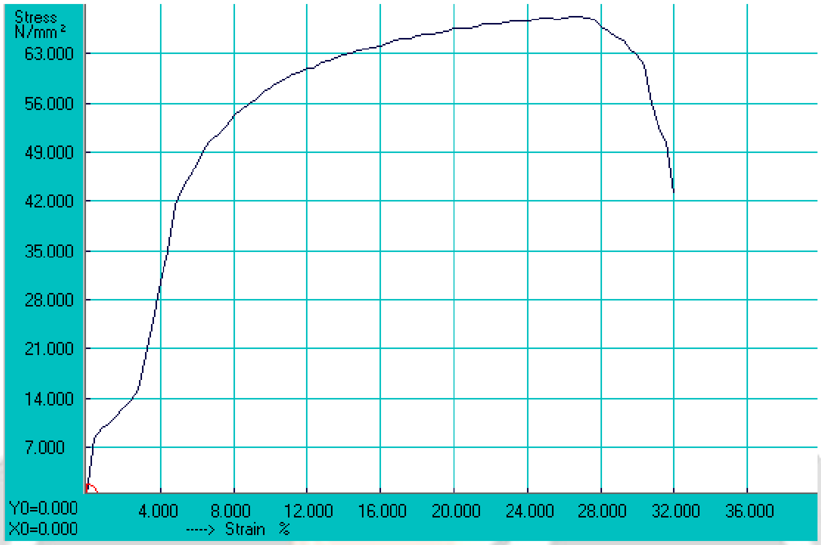
5.3 TENSILE TEST OF SPECIMEN 3

The Tensile process of specimen 3 contains (97% AL 8011+2% SILICON CARBIDE+1% BORON CARBIDE

Fig-3 Tesile test specimen after the test

DISPLACEMENT IN MM	LOAD IN KN	DISPLACEMENT IN MM	LOAD IN KN
0	0.03	3.9	2.36
0.1	0.1	4.0	2.375
0.2	0.15	4.1	2.38
0.3	0.21	4.2	2.385
0.4	0.24	4.3	2.395
0.5	0.285	4.4	2.41
0.6	0.355	4.5	2.41
0.7	0.41	4.6	2.42
0.8	0.49	4.7	2.43
0.9	0.605	4.8	2.44
1.0	0.79	4.9	2.445
1.1	0.93	5.0	2.45
1.2	1.045	5.1	2.46
1.3	1.195	5.2	2.47
1.4	1.46	5.3	2.475
1.5	1.6	5.4	2.475
1.6	1.71	5.5	2.485
1.7	1.805	5.6	2.495
1.8	1.905	5.7	2.495
1.9	1.96	5.8	2.495
2.0	1.995	5.9	2.505
2.1	2.025	6.0	2.515
2.2	2.07	6.1	2.515
2.3	2.1	6.2	2.515
2.4	2.13	6.3	2.52
2.5	2.145	6.4	2.23
2.6	2.175	6.5	2.535
2.7	2.2	6.6	2.53
2.8	2.22	6.7	2.54
2.9	2.235	6.8	2.545
3.0	2.25	6.9	2.545
3.1	2.27	7.0	2.545
3.2	2.285	7.1	2.55
3.3	2.295	7.2	2.555
3.4	2.305	7.3	2.555
3.5	2.32	7.4	2.555
3.6	2.335	7.5	2.555
3.7	2.34	7.6	2.56
3.8	2.35	7.7	2.56

GRAPH -3:



Stress vs Strain

CONCLUSION

Aluminium 8011 / Silicone Carbide / Boron Carbide, with three various amounts of combination have been successfully fabricated by stir casting method. Aluminium is tested by tensile. Hence, the comparison of all tested results shows Al 8011 (97%) + SiC (2%) + B4C(1%) is best composition to give low weight, high strength, high hardness level. The greatest advantage of composite materials is strength and stiffness combined with lightness. By choosing an appropriate combination of reinforcement and matrix material, manufacturers can produce properties that exactly fit the requirements for a particular structure for a particular purpose.

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