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Effect of Reinforcement on Mechanical Properties of Al7475/Nbc/Mos2 Metal Matrix Composites

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EFFECT OF REINFORCEMENT ON MECHANICAL PROPERTIES OF Al7475/NbC/MoS_2 METAL MATRIX COMPOSITES

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ABSTRACT

Aluminum metal matrix composites (AMMCs) have significant applications in aviation, auto and military, because of their high solidarity to wear proportion, resolution, light weight, great wear resistance and improved thermal properties. Abrasive particles, for example, Al_2O_3, SiC, TiC, B_4C are the most generally utilized materials for strengthening aluminum. In this paper the proposed work is to investigate the effect of reinforcement on mechanical properties of Al7475/ NbC/MoS_2 Metal Matrix Composites by fabricating the composites using liquid metallurgical technique by varying the weight percentage (wt%) of reinforcement Niobium Carbide (NbC) and Molybdenum disulphide(MoS_2) from 2 to 10% by intervals of 2wt%.[1,2]

Key words: *Aluminium Alloy (Al7475), Niobium Carbide (NbC), Molybdenum disulphide (MoS_2).*

1. Introduction

Nowadays, composites are profoundly thriving as the replacement of ferrous alloys. The Aluminum manifested into a great substitute due to its properties like lightweight, low density, high strength, and corrosion resistance. The proposed work is to fabricate and determine the mechanical properties such as hardness, fracture toughness of Al7475+NbC+ MoS_2 composites. The composites were developed by Liquid Metallurgy technique [3-4].

2. Material selection

2.1 Matrix Material: Aluminium Alloys

Al7475 is a precipitation solidifying aluminum composite, containing magnesium and silicon as its major alloying components. Al7475 alloys have great mechanical properties with ductility and furthermore they are effectively weldable composites. Al7475 will be utilized as Matrix composite because of its amazing casting properties, sensible strength and its reasonableness for large scale manufacturing. Because of their great properties they discover numerous applications in various fields. [5-15]

Fig.1 Al7475 Ingots

Table.1 Chemical Composition of Al7475 Alloy

Element		Composition
Silicon	Si	0.12
Iron	Fe	0.15
Copper	Cu	2.6
Manganese	Mn	0.10
Magnesium	Mg	2.6
Chromium	Cr	0.04
Zinc	Zn	6.5
Aluminium (Balance)	Al	87.89

2.2 Reinforcement Materials

Niobium Carbide (NbC) and Molybdenum disulfide (MoS_2) are individually used with a varying wt. % of 2, 4, 6, 8, and 10%.

Figure 2.1 Niobium Carbide (NbC) powders of 30 micron size, Fig 2.2 show the SEM image of NbC powders. Fig 2.3 Molybdenum disulfide (MoS_2) powders.

Fig 2.1 Niobium Carbide (NbC) powders

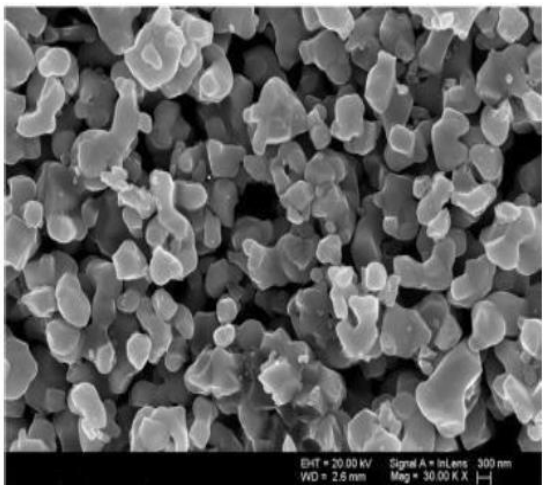

Fig 2.2 SEM image of NbC powders

Fig 2.3 Molybdenum disulfide (MoS_2) powders

2.3 Fabrication of the Composites

The proposed work is to fabricate and determine the mechanical properties such as hardness, fracture toughness of Al7475+NbC+ MoS_2 composites. The composites were developed by Liquid Metallurgy technique.

Fig 2.4 Casted specimens

2.4 Weight variation of reinforcements

Sample	Matrix Material	%Wt of NbC	%Wt of MoS_2
Sample 1	Al7475	2	2
Sample 2	Al7475	4	4
Sample 3	Al7475	6	6
Sample 4	Al7475	8	8
Sample 5	Al7475	10	10

For example 2% Wt of reinforcements means, for every 1000gms of Al7475, 20gms of each reinforcements are added in the casting process.

2.5 Melting points of matrix and reinforcement materials

Sl no	Materials	Melting point in ^{o}C
1	Al7475	546
2	NbC	3490
3	MoS_2	2375

2.6 Existence of Al7475/NbC/MoS_2 in EDS spectrum Analysis

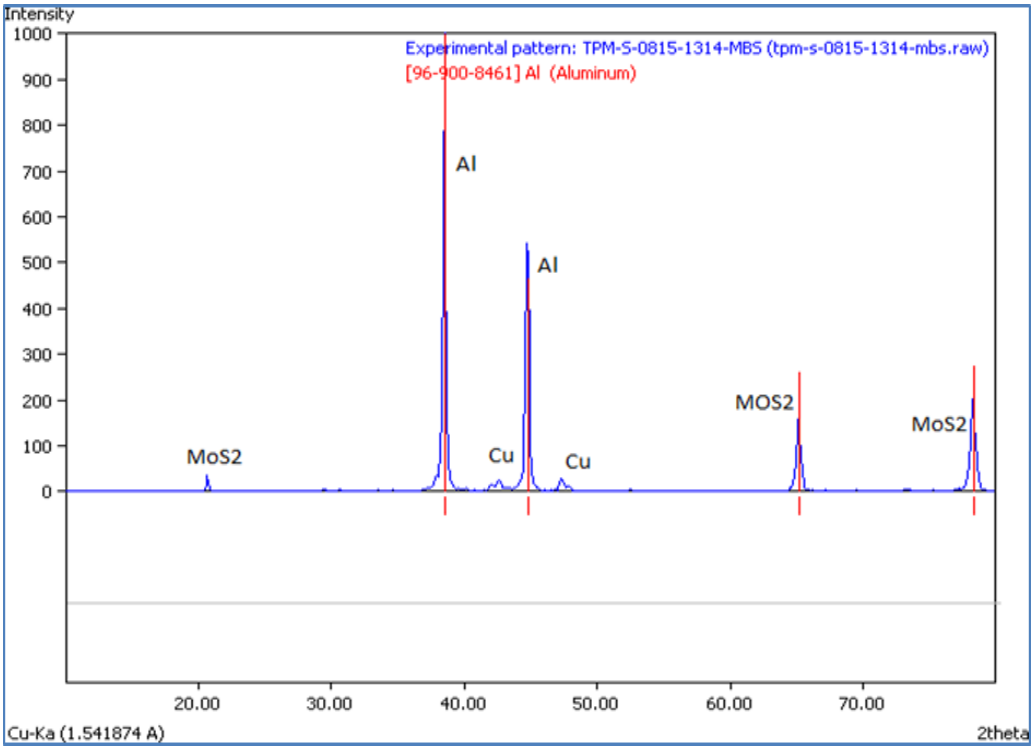

Fig 2.6.1 EDS spectrum Analysis of Al7475/NbC/MoS_2

3. Results and Discussions

3.1 Hardness Test of Composites with NbC and MoS_2 (ASTM STANDARD E10)

The hardness test is conducted by using the Brinell hardness tester as per the ASTM E10.

Sl No	Composition	Brinell Hardness
1	Al7475Alloy	61.7
2	Al7475 +2%NbC	73.4
3	Al7475 +4%NbC	82.3
4	Al7475 +6%NbC	88.7
5	Al7475 +8%NbC	99.3
6	Al7475 +10%NbC	94.5

Table 3.1.Brinell hardness number for various compositions of Al7475/NbC composites.

Sl No	Composition	Brinell Hardness
1	Al7475Alloy	61.7
2	Al7475+2%MoS_2	65.65
3	Al7475+4%MoS_2	71.25
4	Al7475+6%MoS_2	74.25
5	Al7475+8%MoS_2	76.25
6	Al7475+10%MoS_2	72.22

Table3.2Brinell hardness number for various compositions of Al7475/ MoS_2 composites.

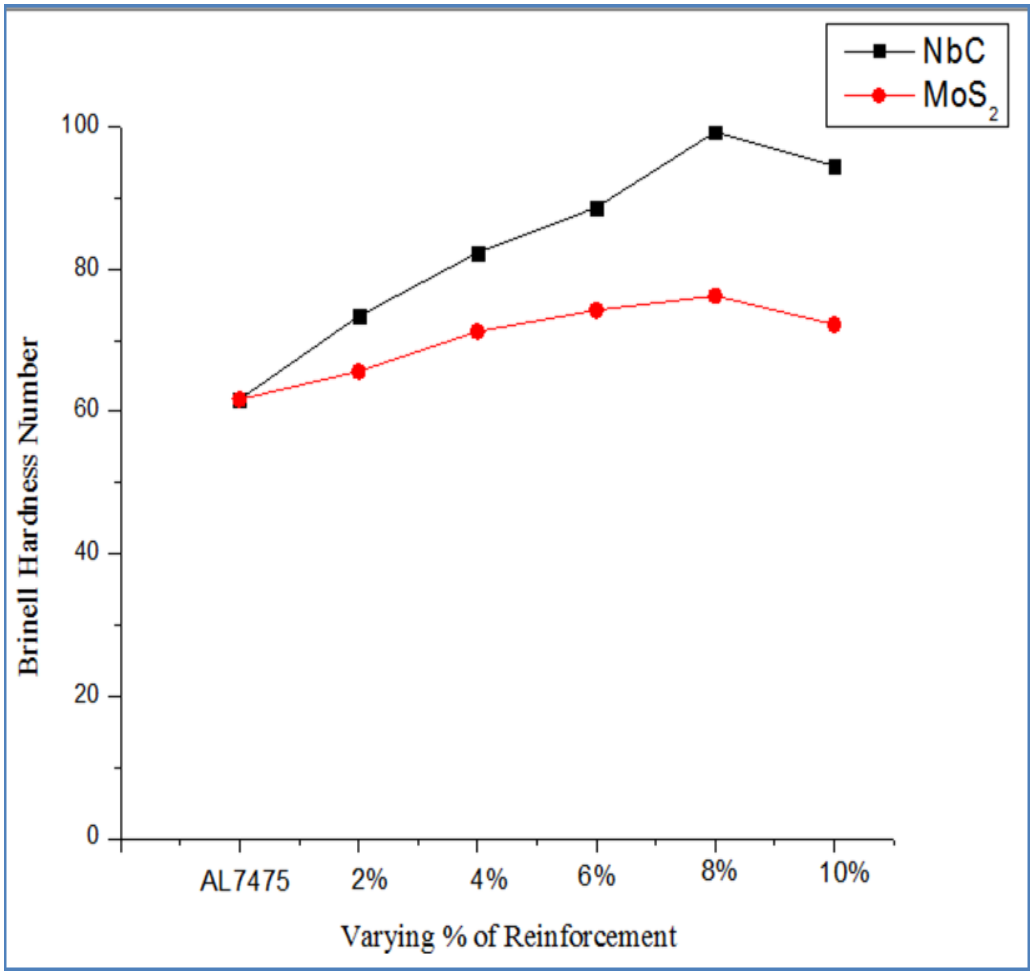

Fig 3.3 shows the BHN values for varying percentage of NbC and MoS_2 reinforcement

3.2 Fracture Toughness

Charpy Impact test is used to determine the toughness of the composite material. Tests are carried out to determine the quantity of energy that is being absorbed by the material before failure by using ASTM standard **(ASTM E23)**

Test samples are prepared as per the standard with a dimension of 10mm * 10mm * 55m with 'U' notch with depth of 2mm at the middle section of the sample.

Sl.No	% of Reinforcement	Fracture Toughness (J/cm^2)
1	Al7475	16
2	Al7475+2%NbC	11.8
3	Al7475+4%NbC	9.2
4	Al7475+6%NbC	8.4
5	Al7475+8%NbC	6.4
6	Al7475+10%NbC	7.2

Table 3.4. Fracture Toughness for Al7475 and Al7475/NbC composites.

Sl No	% of Reinforcement	Fracture Toughness (J/cm2)
1	Al7475	16
2	Al7475+2%MoS_2	14.4
3	Al7475+4%MoS_2	13
4	Al7475+6%MoS_2	12.5
5	Al7475+8%MoS_2	11.8
6	Al7475+10%MoS_2	10.9

Table 3.5. Fracture Toughness for Al7475 and Al7475/ MoS_2 composites

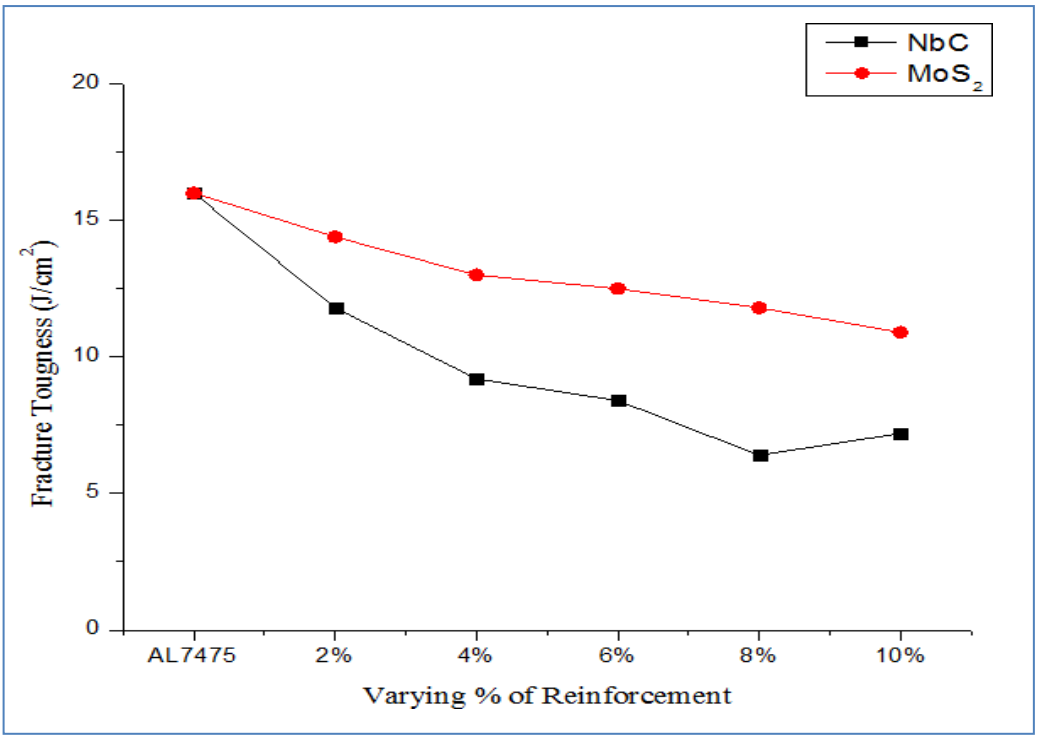

Fig 3.6 shows the fracture toughness of varying NbC and MoS_2 reinforcements

4. CONCLUSIONS

1. AL7475 + NbC+ MoS_2 composite were prepared successfully using liquid metallurgy techniques by incorporating the reinforcing particulates.
2. The obtained casting was uniform with very minimum amount of blowholes, Defects in the casting was done by visual inspection and it also reveals good bonding among matrix and reinforcement particles, which yields better load transfer ability from matrix to reinforcement material.
3. It was found that Brinell hardness of AL7475 + NbC+ MoS_2 is increased with increase in percentage of NbC & MoS_2 from 0 to 8% and an maximum value is reached upto 8%. Further increase to 10% results in decrease of hardness. This is due to improper bonding between the matrix and reinforcements.
4. It was found that fracture toughness of AL7475 + NbC+ MoS_2 is decreased with increase in percentage of NbC & MoS_2 from 0 to 8% and an minimum value is reached upto 8%. Further increase to 10% results in increase of fracture toughness. This is due to voids created between matrix and reinforcements.

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