Development and Characterization of Al7475/NbC Reniforced Metal Matrix Composites

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Aluminium metal matrix composites (AMMCs) have considerable applications in aerospace, automotive and military industries due to their high strength to wear ratio, stiffness, light weight, good wear resistance and improved thermal and electrical properties. Ceramic particles such as Al2O3, SiC are the most widely used materials for reinforcement of aluminium. In the present work, an effort is made to enhance the mechanical properties like tensile strength, compression strength and hardness of AMMCs by reinforcing AL7475 matrix with varying NBC particles sizes. By stir casting route (liquid metallurgical technique) in which amount of reinforcement is varied from 2-8 wt% in steps of 2 wt% for varying reinforcement sizes and specimens are artificially aged. The prepared composites of AL7475-Boron Carbide (NBC) are characterized by microstructural studies, SEM and XRD/EDS analysis will be carried out to analyze the microstructure and the dispersion of the reinforced particles in the alloy matrix, mechanical properties such as Tensile strength, Compression Strength, Density, Tribological Properties and Fracture Toughness as per ASTM Standards. Hypothesis of the present work in particularly to the optimum size of reinforcement and also the results of both with and without heat treatment are compared with that of as cast AL7475 Alloy.

Keywords: AMMCs, AL7475-Boron Carbide (NBC), MoS2 ASTM Standards

I. INTRODUCTION

Aluminium metal matrix composites(AMMCs) have considerable applications in aerospace, automotive and military industries due to their high strength to wear ratio, stiffness, light weight, good wear resistance and improved thermal and electrical properties [1-2]. Ceramic particles such as Al2O3, SiC are the most widely used materials for reinforcement of aluminium.

Boron carbide (NBC) could be an alternative to SiC and Al2O3 due to its high hardness (the third hardest material after diamond and boron nitride). Boron carbide has attractive properties like high strength, low density (2.52 g/cm3), extremely high hardness, good wear resistance and good chemical stability [3]. There has been an increasing interest in composites containing low density [4-6]. Suggested applications for Al-NBC composites include their use as structural neutron absorber, armour plate materials and as a substrate material for computer hard disks. [7-8]. Aluminum matrix composites (AMMCs) are emerging as advance engineering materials due to their strength, ductility and toughness. The aluminium matrix can be strengthened by reinforcing with hard ceramic particles like SiC, Al2O3, NBC etc.

In the present work, an effort is made to enhance the mechanical properties like tensile strength, compression strength and hardness of AMMCs by reinforcing AL7475 matrix with varying NBC particles sizes. By stir casting route (liquid metallurgical technique) in which amount of reinforcement is varied from 2-8 wt% in steps of 2 wt% for varying reinforcement sizes and specimens are artificially aged.

II. PREPARATION OF MMC

Stir casting method is the basic manufacturing technique used for the manufacture of MMC composites.

Testing of composites

The prepared composites of AL7475-Boron Carbide (NBC) are characterized by microstructural studies, SEM and XRD/EDS analysis will be carried out to analyze the microstructure and the dispersion of the reinforced particles in the alloy matrix, mechanical properties such as Tensile strength, Compression Strength, Density, Tribological

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Properties and Fracture Toughness as per ASTM Standards. Hypothesis of the present work in particularly to the optimum size of reinforcement and also the results of both with and without heat treatment are compared with that of as cast AL7475 Alloy.

III. RESULTS AND DISCUSSIONS

1.1 Tensile strength (ASTM E8-82)

Sl No	Composition	Ultimate Tensile Strength (MPa)	Yield Strength (MPa)
1	AL7475 Alloy	163.60	143.0
2	AL7475 + 2% NBC	186.629	172.853
3	AL7475 + 4% NBC	201.884	195.715
4	AL7475 + 6% NBC	218.862	212.593
5	AL7475 + 8% NBC	241.660	234.241

Table 1.1: Tensile Strength for AL7475+NBC MMC

1.2 Compression Test (ASTM E9)

Sl No	Composition	Compression Strength (MPa)
1	AL7475 Alloy	572
2	AL7475 + 2% NBC	652.80
3	AL7475 + 4% NBC	927
4	AL7475 + 6% NBC	1056
5	AL7475 + 8% NBC	1210

Table 1.2: Compression Strength for AL7475+NBC MMC

1.3 Hardness Test (BRINELL HARDNESS TEST)

Sl No	Composition	Hardness Test(BHN)
1	AL7475 Alloy	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

Table 1.3: Hardness Test for AL7475+NBC MMC

IV. CONCLUSIONS

1. AL7475 + NBC composite was prepared successfully using liquid metallurgy techniques by incorporating the reinforcing particulates
2. It was found that increasing the NBC content within the aluminium matrix results in significant increase in the Ultimate Tensile Strength by 31.54% and Yield strength by 34.70% compared to that of AL7475 alloy.
3. It was found that increasing the NBC content within the matrix material, resulted in increase in compressive strength by 52.72% compared to that of AL7475 alloy.
4. As the NBC content is increased from 0% to 8%, the hardness increased by about 37.86 %. The increase in hardness can be attributed to the presence of hard NBC particulates that impart strength to the matrix alloy, thereby providing enhanced resistance to indentation or scratch.

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