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Heat treatment on aluminum hybrid metal matrix composites

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ABSTRACT

The Al alloy matrix materials exhibiting excellent mechanical properties with the addition of B4C particulates as reinforcement. Stir cast method is preferred for preparing composite specimen materials. Then the composites were prepared for heat treatment process by subjecting to solutionizing followed by quenching in different media for improving the mechanical and physical properties. Further, all the specimens are subjected to artificial aging at a temperature of 130˚C for different time duration. The hardness properties are examined. Due to excellent increase in the hardness the material removal rate decreases. It is also observed that Al hybrid metal matrix composite experimented under identical heat treatment conditions reveal significant enhancement in hardness.

Keywords: *HAMMCs, Solutionizing, Artificial ageing*

1.INTRODUCTION

In the recent development, metal matrix composites congregate to meet theincreasing overall demand for light weight, high performance, eco-friendly, wear, and corrosion resistant materials. The Hybrid Metal Matrix Composites (HMMCs) are in advance extensively used in some areas due to its enhanced mechanical properties (and lighter density) when compared with metals/alloys, particularly in applications where weight and strength are of most important consequence. The advantages of particulate reinforced composites over others are their formability with expenditure benefit and its different strengthening mechanisms [1]. Hybrid Aluminium Metal Matrix Composites (HAMMCs) are suitable for appliances which oblige characteristics such as combined strength, damping properties thermal conductivity, andco-efficient of thermal expansionalong with lesser density. The unique properties of HAMMCs enhance their usage in automotive and tribological applications [2-4] such as in pistons, brake drum, brake disc and cylinder block. The current improvement in metallic matrices, for the fabrication of HAMMCs consist of generally used metals viz., Al, Mg, Ti, Cu and their alloys reinforced with hard ceramic particles usually silicon carbide, alumina, [5,6] and soft particles usually graphite, talc etc.[7,8]. The reinforcements like fibers, whiskers,and particulates [9] areemployed particularly in Al-alloy composites leading to the latest invention of tailorable engineering materials with superior specific properties [10, 11]. This creates significance among the researchers to deliberate both on investigational and systematic segments of HAMMCs to expand an enhanced perceptive about the mechanical behavior of these materials and their exceptional wear resistance.

In engineering materials system, the heat treatment processes are incredibly essential for improving the composite material properties. The main purpose of the heat treatment is to create the material system structurally and physically strong and fit for engineering application [12]. Heat treatment of aluminum alloys favors the maximum concentration of hardening solute to dissolve into solution. This method is suspiciously conceded out by heat treatment of an alloy to a temperature at which one single, solid phase exists. By this heat treatment, the solute atoms that are originally part of a two-phase solid dissolve into solution and originates as one single phase. Once the alloy is heated to the recommended solutionizing temperature, it is quenched

at a rapid rate such that the solute atoms don't have enough time to precipitate out of the solution. As a result of the quench, a super saturated solution now exists between solute and aluminum matrix [13, 14].

Fig. 1: Stir Casting Set up

Preparation of Hybrid Aluminum Metal Matrix Composites (HAMMCs)

In the present work, stir casting technique is used to fabricate Al 7075 alloys with varying weight percentage of SiCand B4C reinforcement. In order to achieve good binding between the matrix and particulates, one weight percent of magnesium alloy is added. The stir casting set up is shown in the Fig 1. Temperature can be easily controlled and measured.The stirreris used to stir the molten metal in semi-solid state. The melt was maintained at a temperature between 750 to 800˚Cfor one hour. Vortex was created by using a mechanical stirrer.A load of 500 Kgf for a period of 30 seconds was applied with a ball indenter of 10 mm diameter. The test was carried out at five different regions. Hardness was determined by measuring the indentations diameter produced. The average of all the five readings was taken as the hardness of the composite.

Heat Treatment Process

Al matrix alloy withB4C particulates reinforcedcomposites were subjected to solutionizing treatment at a temperature of 480˚C for a period of 2hr using muffle furnace, followed by quenching in three quenchantsviz, air, Artificial ageing treatment was carried out for the duration of 2 hr to 10 hr in steps of 2 hr.

2.RESULTS and DISCUSSION

Hardness Survey:

Hardness test was carried out usingBrinell hardness tester with six indentations of each sample and then the average values were used to calculate hardness number. A considerable increase in hardness of the matrix was seen with the addition of SiB_4C particles.The hardness of HAMMCs increases with the weight fraction of particulate in the alloy matrix. It is observed that with increased weight % of reinforcement in the matrix alloy, there is a significant improvement in the hardness of the composites.The hardness of HAMMCs increases with a weightpercentage of particulate in the Alalloy matrix. Maximum hardness wasmeasured for Al7075 7% B4C composites. On air quenching and ageing for 8 hr, a maximumimprovement in hardness around 28%,

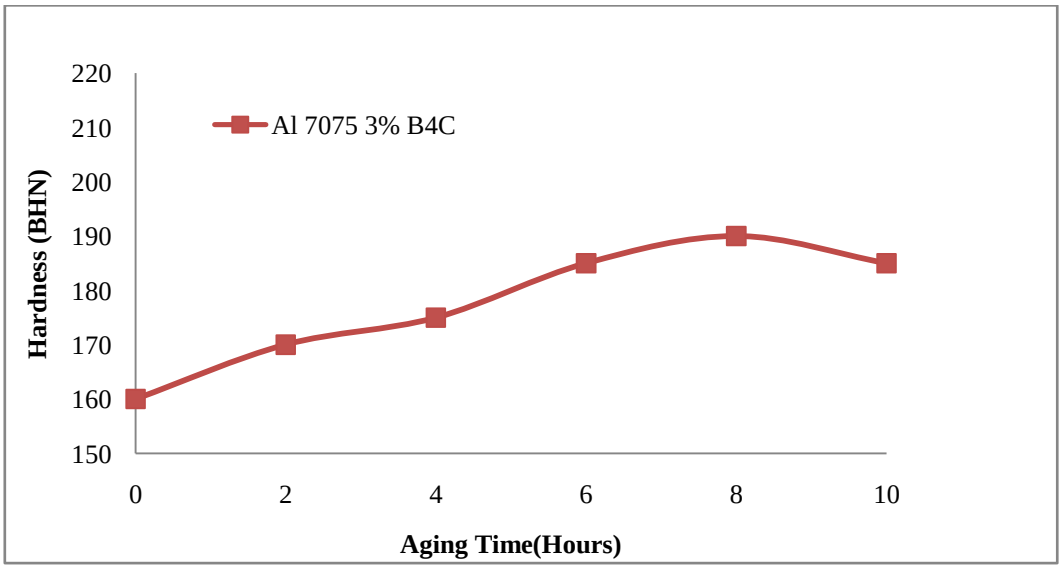

Fig. 2:Solutionizing Temperature: 480˚C, Quenching Media: Air, Ageing Temp: 120˚C

3.CONCLUSION

The hardness of composites increased significantly with increased content of B_4C. Heat treatment has a significant effect on the hardness of Almatrix composites.

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