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Persuade of heat treatment effect on metal matrix composites

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ABSTRACT

The Al 7075 alloy matrix materials possess mechanical properties with the addition of B4C particulates as reinforcement. Liquid metallurgy route is used for fabricating composite workpiece. Composites were held for heat treatment process by subjecting to solutionizing followed by quenching in ice media for improving the mechanical properties. Then the specimens are subjected to artificial aging at a temperature of 130˚C for various time duration. The hardness properties are evaluated for the composite materials before and after heat treatment.

Keywords: *Aluminium alloy, Artificial ageing, Hardness*

1. INTRODUCTION

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 [1]. 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 supersaturated solution now exists between solute and aluminum matrix [2, 3].

Rapid quenching creates a saturated solution resulting in increased hardness and mechanical properties of the material system. In addition to these studies, the highest degree of corrosion resistance is obtained through maximum rates of quenching [4]. Quenching takes place in three distinct stages namely vapour blanket stage, boiling stage and liquid cooling stage. The vapour blanket stage begins when hot part submerged in an unbroken blanket which surrounds the object. This blanket exists between the specimen and quenching media if the heat from the surface of the object exceeds the amount of heat needed to form maximum vapour per unit area of the object.
Previous studies [5-14] of the ageing behavior of the composite with discontinuous ceramic reinforcement are different from that of the aluminum matrix alloys.

Materials selection
In this paper, B4C particulates reinforced with Al 7075 matrix composite was chosen. The nominal chemical composition of Al 7075 alloy is given in Table 1. The hardness of the specimens was measured using Brinell microhardness tester by applying a load of 200 kgf and the average hardness from 10 different data of the experiments was considered.

Table 1: Chemical composition of Al7075 by weight percentage

Elements	Si	Fe	Cu	Mn	Ni	Zn	Ti	Mg	Cr	Al
% wt	0.06	0.18	1.62	0.074	0.05	5.62	0.049	2.52	0.22	Balance

Preparation of Hybrid Aluminum Metal Matrix Composites (HAMMCs)

Liquid metallurgy route is used to manufacture Al 7075 alloys with a varying weight percentage of B4C reinforcement. The stirrer is used to stir the molten metal in a semi-solid state. The melt was maintained at a temperature of 850˚C for one hour. Vortex was created by using a mechanical stirrer. One specimen Al7075 reinforced with 3% B4C, were made with the same procedure. Hardness measurements were carried out on the specimen. Specimen were tested using Brinell hardness tester machine. A load of 200 Kgf for a period of 20 seconds was applied with a ball indenter of 10 mm diameter. The test was carried out at 10 different regions. Hardness was determined by measuring the indentations diameter produced. The average of all the ten readings was taken as the hardness of the composite.

Heat Treatment Process

Al 7075 matrix alloy with B4C particulates reinforced composites were subjected to solutionizing treatment at a temperature of 480˚C for a period of 2 hr using muffle furnace, followed by quenching in three different quenchants viz, ice. .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 using Brinell hardness tester 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 B4C particles. 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 weight percentage of particulate in the Al alloy matrix.

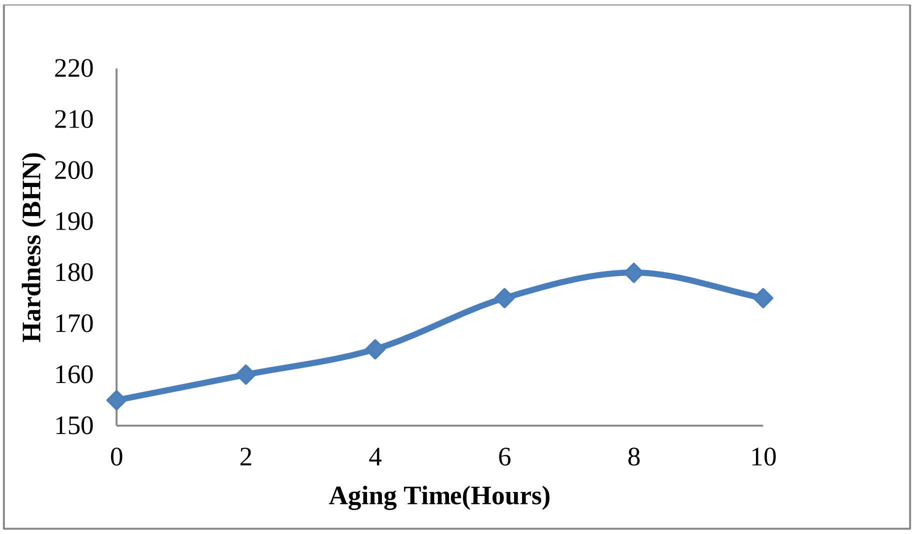

Fig 1: Solutionizing Temperature: 480˚C, Quenching Media: Ice, Ageing Temp: 130˚C

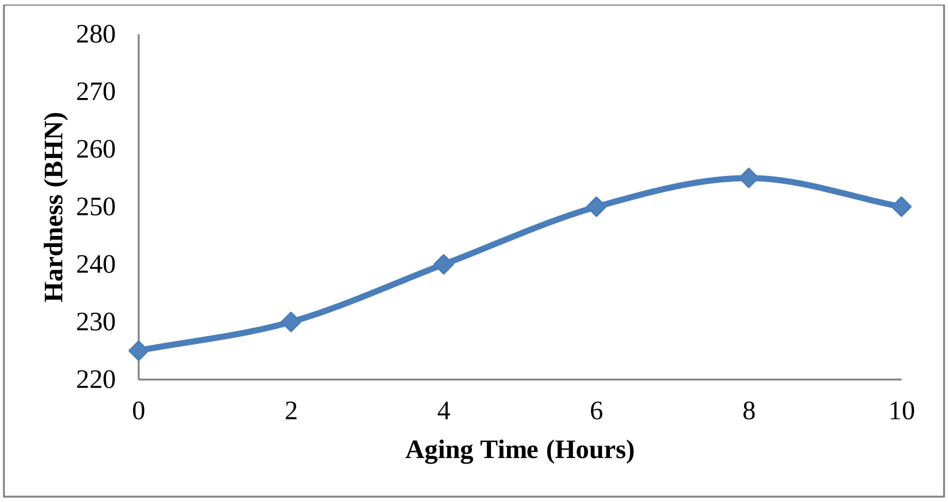

Fig 2: Solutionizing Temperature: 480˚C, Quenching Media: Ice, Ageing Temp: 130˚C

3. CONCLUSION

Hardness considerably increases with ageing duration, reaches a peak value at 8 hr and with further increase in ageing duration, there is a decrease in hardness. The hardness of composites increased with increased content of B4C. Heat treatment has a significant effect on the hardness of Al 7075 matrix composites.

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