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Tribological studies on mechanical properties of metal matrix composites

G. Ramesh

gramesh_me@yahoo.co.in

MEA Engineering College,
Malappuram,
Kerala

V. C. Uvaraja

gramesh_me@yahoo.co.in

Bannari Amman Institute of Technology,
Coimbatore, Tamil Nadu

C. V. Suraj

gramesh_me@yahoo.co.in

Velammal Engineering College,
Chennai, Tamil Nadu

B. Senthilnathan

gramesh_me@yahoo.co.in

Velammal Engineering College,
Chennai, Tamil Nadu

M. Narendhiran

gramesh_me@yahoo.co.in

Velammal Engineering College,
Chennai, Tamil Nadu

ABSTRACT

The Al 7075 alloy matrix materials possess mechanical properties with the addition of SiC particulates as reinforcement. Liquid Metallurgy method is adopted for preparing composite workpiece. Composites were adopted for heat treatment process by subjecting to solutionizing followed by quenching in water media for improving the mechanical properties. Then the specimens are adopted to artificial aging at a temperature of 130 °C for different time duration. The hardness properties are examined for the composite materials before and after heat treatment. It is seen that Al 7075 composite under heat treatment conditions reveals increase hardness.

Keywords: Composites, Materials, Alloys, Heat treatment.

1. INTRODUCTION

Metal Matrix Composites are in use in areas due to its mechanical properties 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]. Aluminium Metal Matrix Composites are suitable for appliances which oblige characteristics such as combined strength, damping properties thermal conductivity, and co-efficient of thermal expansion along 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] are employed particularly in Al-alloy composites leading to the latest invention of tailorable engineering materials with superior specific properties [10, 11]. The present work is aimed at investigating the consequence of quenching media and aging duration on the hardness property of Al 7075.

2. MATERIALS SELECTION

In this paper, SiC particulates reinforced with Al 7075 matrix composite is selected the nominal chemical composition of Al 7075 alloy is given in Table 1. The hardness of the specimens was measured using brinell micro hardness tester by applying a load of 100 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

Table 2: Reinforcement Size

Particulate	Size	Shape
SiC	20	Angular-Irregular

3. PREPARATION OF HYBRID ALUMINUM METAL MATRIX COMPOSITES (HAMMCS)

Stir casting technique is used to fabricate Al 7075 alloys with a varying weight percentage of SiC reinforcement. The stirrer is used to stir the molten metal in a semi-solid state. The melt was maintained at a temperature between 750 to 800°C for one hour. Vortex was created by using a mechanical stirrer. One specimen Al7075 reinforced with 3% SiC, 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 500 Kgf for a period of 30 seconds was applied with a ball indenter of 10 mm diameter. The test was carried out in 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.

4. HEAT TREATMENT PROCESS

Al 7075 matrix alloy with SiC particulates reinforced composites were subjected to solutionizing treatment at a temperature of 460°C for a period of 2 hr using muffle furnace, followed by quenching in three different quenchants viz, air, and water. Artificial aging treatment was carried out for the duration of 2 hr to 10 hr in steps of 2 hr.

5. 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 SiC 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.

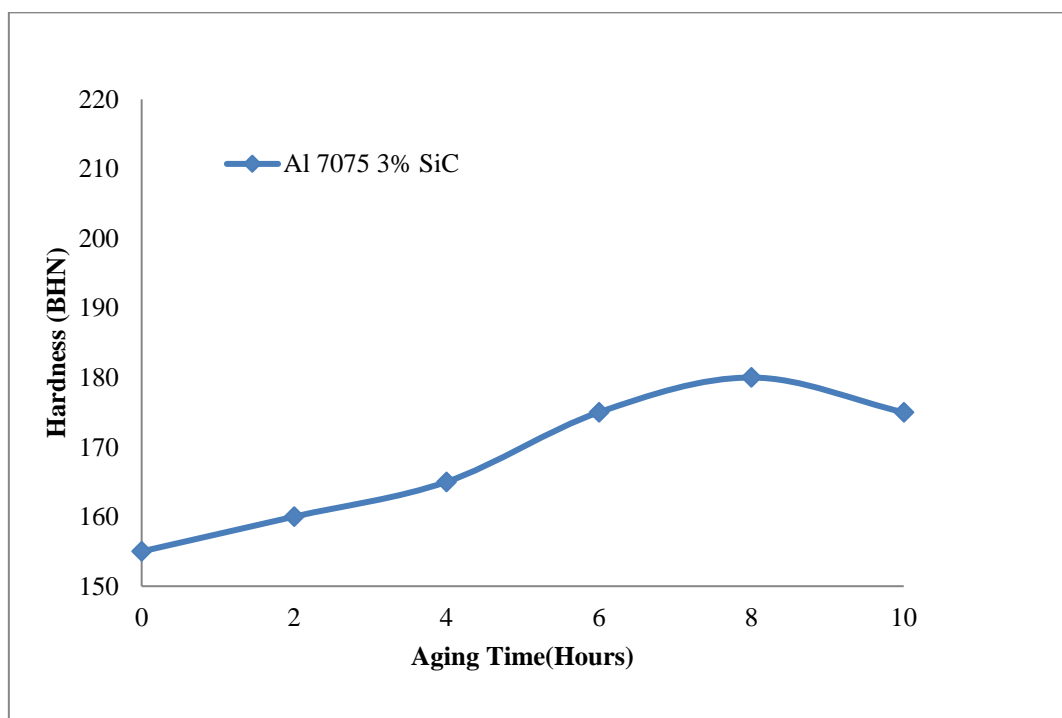


Fig 1 Solutionizing Temperature: 460°C, Quenching Media: Air, Ageing Temp: 130°C

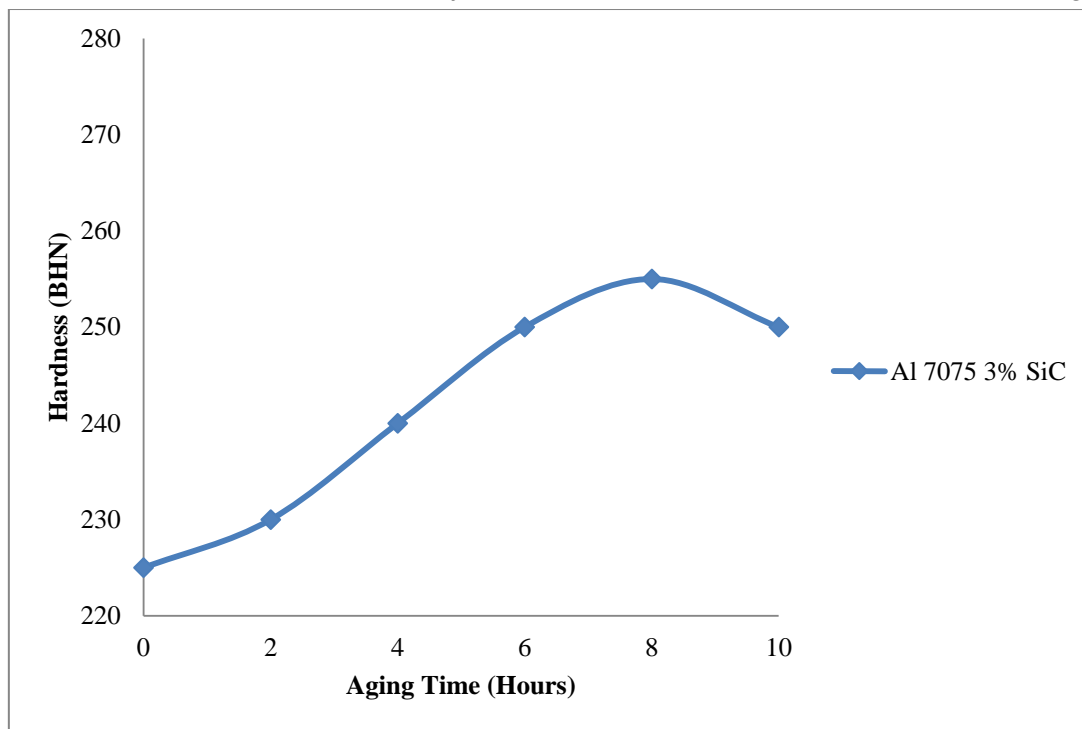


Fig 2 Solutionizing Temperature: 460°C, Quenching Media: Water, Ageing Temp: 130°C

6. CONCLUSION

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

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