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Effect of shot peening on surface properties of Al7075 hybrid aluminum metal matrix composites

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ABSTRACT

Various fields of engineering such as automobile, aerospace and construction industries are employs Aluminum alloys and its composites due to its high strength to weight ratio. But they possess poor wear resistance due to low hardness. In this research, shot peening treatment is used to enhance the wear resistance ability of the composites. Micro hardness and surface roughness of AL7075 Hybrid metal matrix composites are examined after shot peening treatment. For this, the aluminum alloy specimens are subjected to shot peening for 30, 60, 90, 120 and 150 s time. The results reveal that the shot peening treatment increases micro -hardness and surface roughness up to 90 s. The specimen after 120 s peening demonstrates the marginal improvement in micro hardness and slight reduction in surface roughness.

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1. Introduction

The monolithic materials possess limitations in regard to attainable combinations of strength, stiffness, and density. In order to improve these shortages and to fulfill the growing engineering demands of modern technology, metal matrix composites are attracting many researchers towards it. The applications of composite materials are increasing rapidly and have even found new markets [1,2]. Due to its superior material properties like high stiffness to weight ratio and high impact strength and fracture toughness, Metal Matrix Composites (MMC) were highly recognized as better materials for engineering applications compared to the conventional materials [3].

The aim of the now a days researcher is to produce them durable in tough conditions to substitute other materials. The aerospace industry applies metal matrix composite extensively because of its better properties [4]. Embedding Nano sized Silicon Carbide (SiC) in the metals make them higher in hardness, wear resistance, and corrosion resistance [5]. Shot peening is considered as best method to enhance the fatigue properties, because it boost the reduction of the crack initiation and also crack established early [6]. Incorporation of large B_4C particles size results in more homogeneous composite microstructure than the composite with smaller B4C particle size due to agglomeration [7].Aluminum reinforced with SiC has been developed by various researchers for understanding the effect of various factors such as the particle size [8], the load [9] and the sliding speed [10] in wear performance. Therefore in the present study the aluminium 7075 matrix reinforced with different weight % of B_4C and SiC has been considered. These reinforcement materials have been selected due to their better mechanical as well as wear properties. Silicon carbide has high strength, high hardness and excellent thermal shock resistance. In this study the Micro hardness as well as surface properties of these hybrid composites are estimated after subjecting these materials to shot peening treatment in order to differentiate the best parameters of shot peening treatment.

2. Material and methods

2.1. Preparation of composites

The aluminium alloy AL7075 used in this experimental study was procured in the form of plate with 5.5 mm thickness from Perfect metals works, Bangalore (India). Hybrid composite were prepared with 7075 aluminum alloy as matrix and SiC and B4C as reinforcements. Samples of the composites were developed by stir casting method. The melting was done in a induction furnace.

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Table 1
Aluminum 7075 properties.

Element	Wt%
Cu	1.32
Mg	2.72
Zn	5.85
Mn	0.05
Si	0.05
Fe	0.13
Cr	0.18
Ti	0.05
Al	Remaining

Table 2
Hybrid metal matrix composites.

Sample Identification	Matrix (AL7075) wt%	B_4C Reinforcement (wt%)	SiC Reinforcement (wt%)
S0	100	–	–
S1	95	2.5	2.5
S2	90	5	5
S3	85	7.5	7.5

Table 1 shows the Chemical composition of the matrix material. The SiC and B4C particles were also preheated at 1000 °C to make their surfaces oxidized to increase the wetting property with in aluminum molten metal. The particle size of the SiC particles varies30-50 µm, and the particle size of B4C varies 40–65 µm. The aluminum scraps were first heated above the liquidus temperature to melt it completely. Then it is slightly cooled below the liquidus to continue the slurry in the semisolid state. The composite slurry was then reheated to a fully liquid state, and mechanical mixing was performed for about 10–15 min at an average mixing speed of 150–300 rpm. The final temperature was controlled to be within 720 °C ± 10 °C, and pouring temperature was controlled to be around 700 °C. After full stirring, the melt was transferred into steel molds of 150 mm x150 x30 mm and allowed to cool to obtain cast samples. Four varieties of Hybrid metal matrix composites were prepared in this way. The samples of 20x20x5 mm were cut from the cast slab for testing purposes. Table 2 shows the various Hybrid metal matrix composites prepared in this study. Fig. 1 shows the testing specimen and its dimensions with shot balls.

Table 3
Parameters of Shot Peening.

Shot material	Steel shot
Shot diameter range (µm)	400–600
Air pressure (bar)	5
Peening duration(s)	30, 60, 90, 120 and 150
Nozzle distance (mm)	50
Impingement angle (°)	90

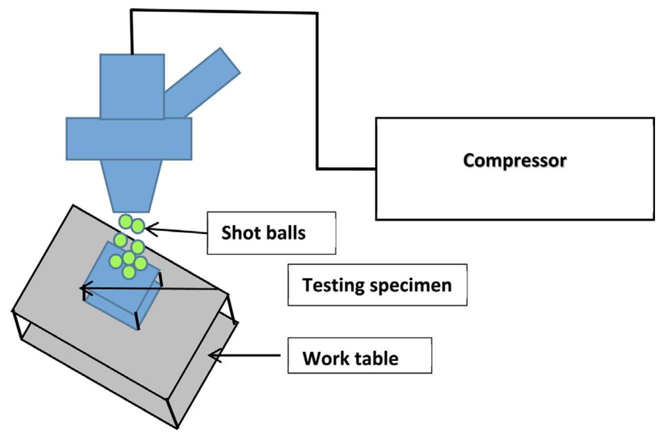

Fig. 2. Schematic layout of shot peening process.

2.2. Shot peening study

The shot peening process was conducted in accordance with MIL-13165 standard under the conditions shown in Table 3. The Fig. 2 illustrates the process schematically with specimens.

3. Results and discussion

3.1. Micro hardness

The micro hardness of pure aluminum is 180at initial condition and micro hardness is 220 at 30sec, 240 at 60sec, 260 at 90sec, 268 at 120sec and 266 at 150sec. The micro hardness difference between pure aluminum and 5% of alloy specimen is 5 at 30sec,

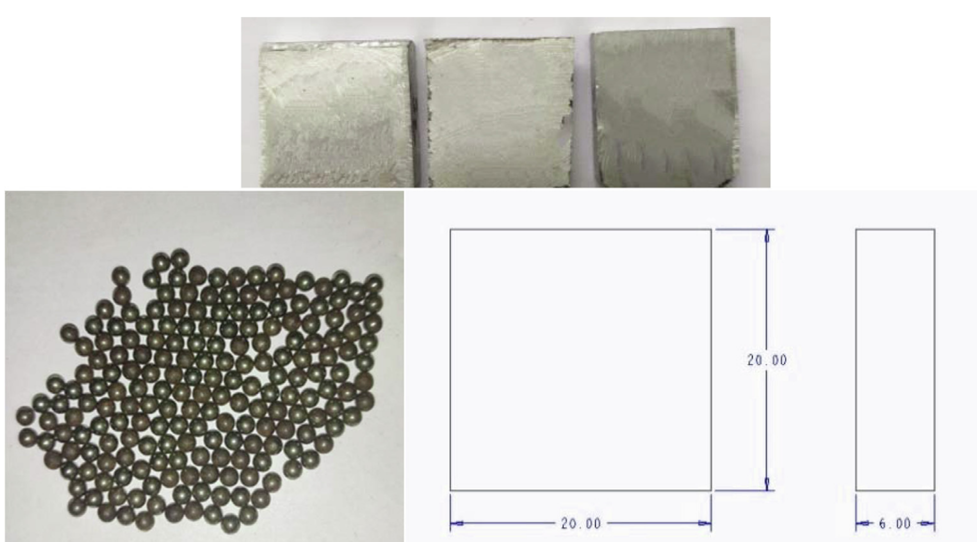

Fig. 1. Testing specimen and dimensions.

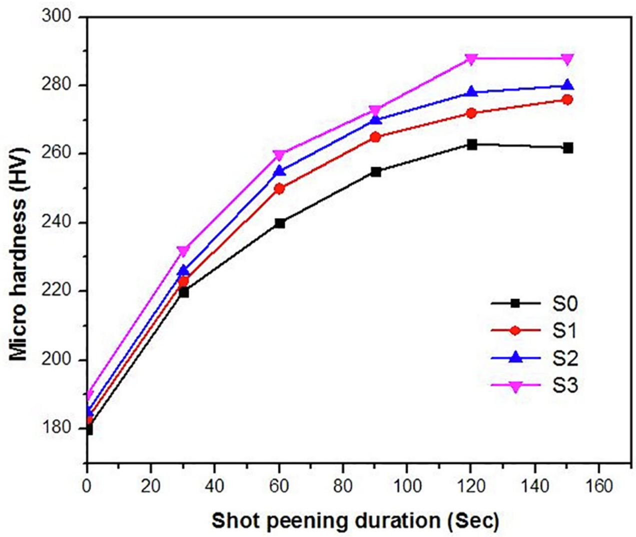

Fig. 3. Micro hardness variation (HV) vs shot peening duration (Sec).

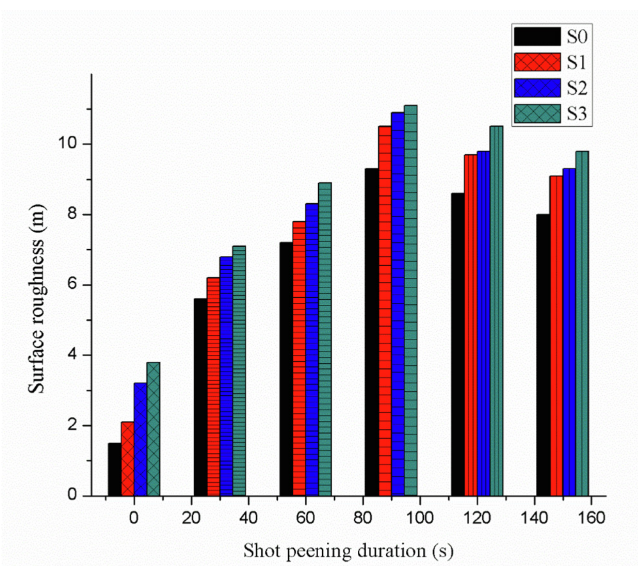

Fig. 4. Variation of surface hardness (m) vs shot peening duration (S).

HV differs 10 at 90sec, 10at 150sec. The micro hardness of 10% alloy specimen difference between pure aluminum is 6 at initial condition, 15 at 90sec and 18 at 150sec. And 15% of alloy content specimen's micro hardness difference between pure aluminum is 10at initial condition, 18 at 90sec and 26 at 150sec. Fig. 3 Micro hardness of Different specimens under different duration of shot peening.

3.2. Surface roughness

The surface roughness of pure aluminum at unpeened condition was 1.5 and surface roughness is also increased gradually till 80th sec at the range of surface roughness is 9 and after that the surface hardness was decreased. And each of surface roughness of 5%, 10% & 15% of alloy contain specimen was increase particular duration and after it all of surface roughness is decreased. Fig. 4 shows the variation of surface roughness of specimens under different duration of shot peening process.

4. Conclusion

Shot peening process improves the surface hardness by producing compressive residual stresses. In this studies, analysis the effects of shot peening on surface roughness and micro hardness was carried out. In this research different weight percentage of reinforcements was used such as 5%, 10% & 15% and concluded that the shot peening process increase the micro hardness and also increase the surface roughness at certain duration but after certain duration the surface roughness is decreased. The reinforcement B_4C and SiC improves the micro hardness rate is proportional to added the weight percentage.

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