Experimental Investigations of Al6061/Sic/Mos2 Hybrid Composites Wear Behavior by using Stir Casting Method

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Abstract— Aluminum alloy (AA6061) is reinforced with fine particulates are produced composite and discussed in this work. The reinforced aluminum alloy hybrid metal matrix composite (HMMCs) with 0 to 12% vol. fractions of Silicon Carbide and molybdenum disulfide reinforcements were created by stir casting technique. The metal to metal wear behavior of these hybrid composite and that of un-reinforced alloy was investigated by pin-on-disc wear testing machine. The optical micrographs in use for the micro structure investigation of the hybrid composite show that the Silicon Carbide and molybdenum disulfide particulates are regularly distributed in the matrix materials. The surfaces of the wear area were analyzed by SEM, which are shown that wear surface of the materials was normally much rougher than that of the non-reinforced alloy.

Key words: HMMCs, SEM, hybrid composite

I. INTRODUCTION

Dry Sliding wear behavior of the composites is important when there is relative motion between metal components [1, 2].To investigate the sliding wear properties of the aluminum MMCs reinforced with different types of reinforcements such as Sic, Al2O3, Tic, TiB2 and graphite [3, 4, 5] there were many research works have been carried out . The sliding wear behavior of the composites were establish to be functions of many factors such as fraction and particle range of reinforcements, hardness and tensile strength of matrix materials, applied load and environmental temperature[6,7]. An understanding of the fundamental mechanism of in order to use them more efficiently. This paper is mainly relevant in the case of Al alloys reinforced with Sic & MoS2. There has been a limited number of research papers on the wear and microstructure aspect of these materials [8, 9]. The purpose of the present investigation is analyzing the worn surface of the dry sliding wear behavior of Al6061 alloy, resistant with Sic and MoS2 particulates. This hybrid metal matrix composite material was fashioned by the stirrer casting method and the wear behavior of composites was investigated using a pin on disc type wear testing machine. The optical micrographs of the test specimens were taken to study. The study wear mechanism of the worn surfaces can be examined by scanning electron microscopy (SEM).

II. MANUFACTURING PROCESS

Amongst the variety of manufacturing processes, the stir casting technique is the simplest and the most economical process for producing particulate reinforced MMCs available for particulate reinforced metal matrix composites [10, 11]. In this technique, in order to accomplish the optimum property of the hybrid composite.

Fig. 1: A Photographic View of Stir Casting Machine

The moisture level with cast composite must be minimized and the element reactions between the particles material and the base material have to be avoided. The whirlpool Method is individual of the enhanced recognized approaches used to build a high quality allocation of the reinforced material in the base matrix. During this, once the base material is melted, it is stirred forcefully by automatic agitator to form a whirlpool at the face of the liquify and the particle material is subsequently introduced at the region of the vortex. Al6061 alloy was melted in a crucible in a generation type of furnace at 725 ºC. Subsequent to melting and Degassing by nitrogen (N), an alumina coated stainless steel (SS) stirrer was meant for stirring at600rpm used foretime duration. During stirring, the preheated at 600 ºC particles Sic (25µm) and MoS2 (45µm) in equivalent quantity of powder was added. After that the composite alloy was roll poured into the pre-heated (250ºC) permanent mould. The Al6061 alloy with different volume fractioned hybrid composites is produced and test specimens were machined.

III. EXPERIMENTAL WORK

At ambient temperature the sliding experiments were conducted in air on a pin on disc wear testing machine which is shown in Fig.1. Before the wear test experiment, all material were position by 1µm alumina powder and 2000 grit paper. Wear tests on metal matrix composite material and strengthened Al alloy were progressed under three different applied weights of 20N, 30N,40N and 50N for a speed of 1.6 m/s,2m/s and 1.3m/s. During the experiment the relative moisture and temp of the neighboring atmosphere is about 50% and 25ºC res. The test period was 15mins at a rated speed of 300rpm. The photography of the wear tested material is shown in Fig.2. The small structures of the metal matrix composite materials were examined by using optical microscopy after prepare them metallographic ally. The porosity rank of the composite material (measured by vol. %) was analyzed using image study techniques. The worn surface of the wear material was examined by SEM (Scanning Electron Microscopy).

Fig. 2: A Photograph View of the Pin-On-Disk Type Wear Testing Machine

Fig. 3: The Photographs View of the Wear Tested Specimen.

IV. RESULTS AND DISCUSSION

The wear of test material attained at constant applied weight, the composite materials show signs of a lower wear failure compared with strengthened Al alloy. Marked effect on the wear was shown by the results which indicate the volume content of the particulate reinforcement. The optical micrographs of strengthened alloy and of the composites with 0% to 12% vol. fraction of reinforcement are shown in Fig.3. The small structure analysis of these materials shows that the Silicon carbide and molybdenum disulfide particulates are regularly scattered in the matrix. However, the existence of porosity around the Silicon carbide and molybdenum disulfide particulates was evident. It was observed that the porosity was more pronounced in the region of molybdenum disulfide particles than the position around Silicon carbide particles. This examination may be recognized to wetting behavior of aluminum alloy. It is also observed from the optical micrographs that the porosity of the material increase with increase in vol. fractions of the reinforced particles.

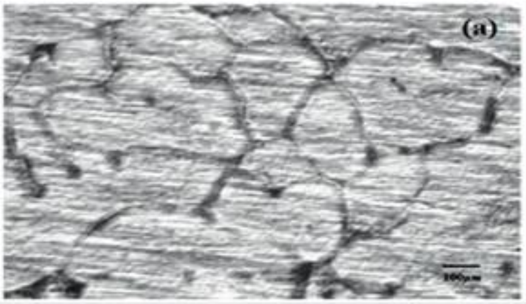


Fig. 3.1: (A) 0% Vol. Fraction

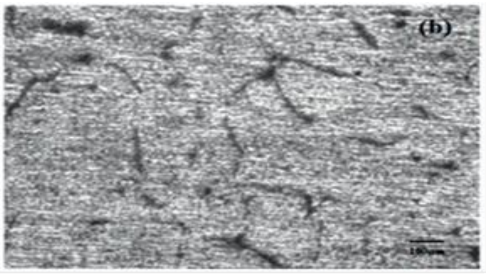


Fig. 3.2: (B) 3% Vol. Fraction

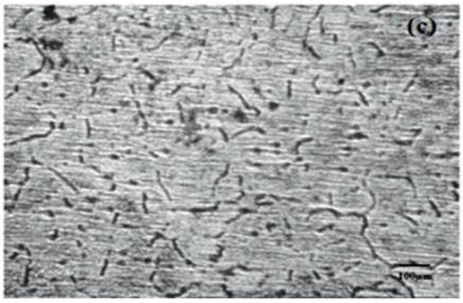


Fig. 3.3: (C) 6% Vol. Fraction

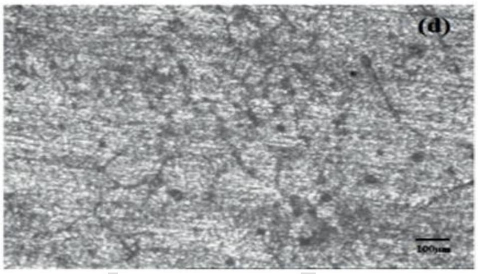


Fig. 3.4: (D) 9% Vol. Fraction

Fig. 3.5: (E) 12% Vol. Fraction

Fig. (3.1-3.5): optical micrographs of magnification 100x of different vol.fraction reinforced HMMC's

The Scanning Electron Microscopic photographs of the worn surface of the strengthened aluminum alloy composites with 0% to 12% vol. fraction, after slippery distance of 1500m under an applied weight of 50N is shown in Fig. 4. The worn surface of the composite alloy was generally much rougher than that of the unreinforced alloy which was shown by the examination of the worn surfaces. In the case of composite alloy, porosity and large grooved section are found on the worn surface. In detail, the ceramic particulates were establishing inside the porosity shows that some particles were wrecked and other particles were drag out from the surface. It shows an abrasive wear mechanism which is effectively a result of hard ceramic particles showing on the worn surface and loose fragments between two surfaces. As the ceramic particles oppose the delimitation process, the wear resistance is more in the case of composites aluminum alloy.

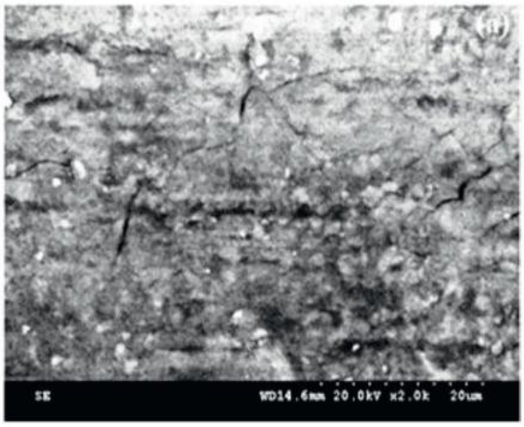


Fig. 4.1: (A) 0% Vol. Fraction

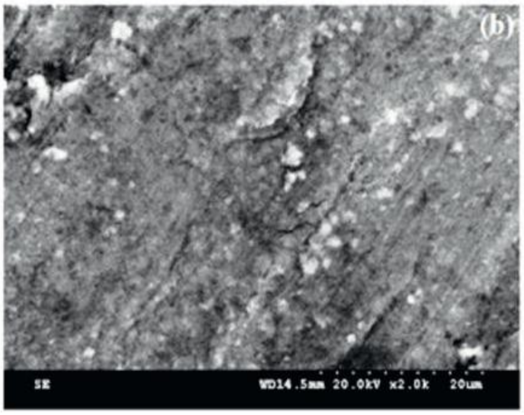


Fig. 4.2: (B) 3% Vol. Fraction

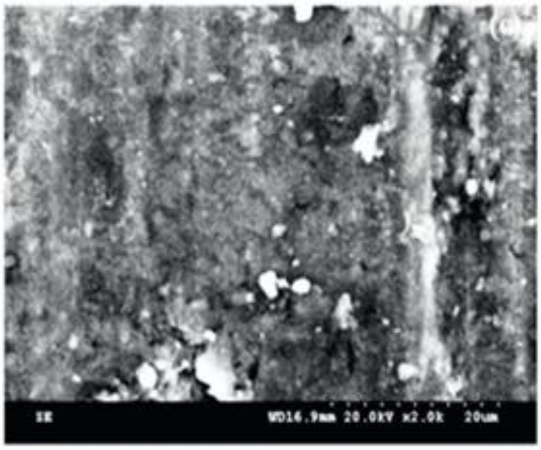


Fig. 4.3: (C) 6% Vol. Fraction

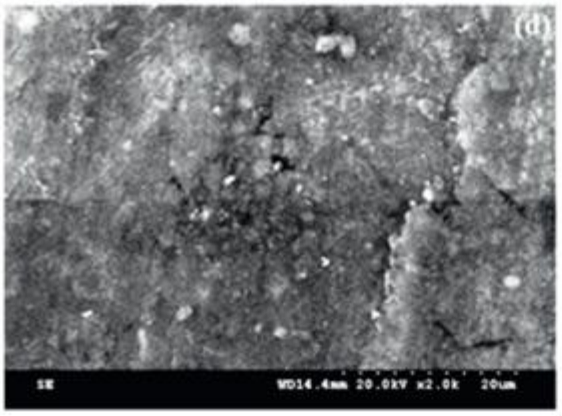


Fig. 4.4: (D) 9% Vol. Fraction

Fig. (4.5): (E) 12% Vol. Fraction

Fig. (4.1 – 4.5): SEM micrographs of magnification 20X of different Vol. fraction reinforced HMMCs at a load of 40N.

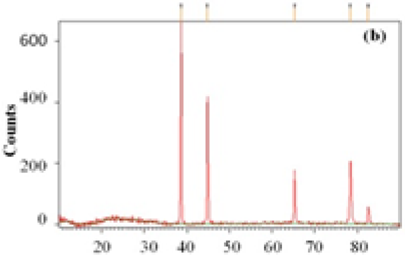
X-ray Diffraction is perhaps the most commonly used x-ray diffraction technique for distinguishing materials. The technique is also used for commonly studying particles in polycrystalline solids (bulk or thin film materials).Therefore when the 2D diffraction pattern is recorded, it displays concentric rings of scattering peaks equivalent to the various 2Dspacing in the crystal lattice. The positions and the concentration of the peaks are used for recognizing the underlying structure of the material. In the MRL x-ray facility, powder diffraction data are calculated using the Philips XPERT MPD diffract meter, which calculates data in reflection mode and is used more often with solid samples. This result displays the peak positions, concentrations, widths and shapes all provide important information about the arrangement of the material. In the XRD patterns, presence of MoS2 and Silicon are obvious in all aluminum alloy hybrid metal matrix composites. The investigation of the microstructure constitutes are marked on the high magnification micrographs.

Pos	Height	FWHM	D spacing	Rel.int%
39.647	299.01	0.2432	2.3797	100.00
45.878	276.12	0.0532	3.03030	95.87
78.229	76.78	0.4312	2.3404	27.28
79.307	108.97	0.6284	2.21998	36.67
85.567	25.678	0.0678	2.2689	9.76

Table 1: Pattern List of XRD TEST 6% Vol. Fraction Reinforced of HMMC

Pos	Height	FWHM	D spacing	Rel.int%
39.647	759.01	0.2432	2.3799	100.00
45.878	376.12	0.0532	3.0211	57.87
78.229	166.78	0.4312	2.3404	27.28
79.307	188.97	0.6284	2.2199	35.67
85.567	54.678	0.0678	2.2689	8.76

Table 2: Pattern List of XRD TEST 6% Vol.Fraction Reinforced of HMMC



(B) 6% Vol. Fraction

Fig. 5: XRD Graphs of Different Vol. Fraction Reinforced HMMCS

V. CONCLUSION

The current examination of the dry sliding metal-metal worn surface behavior of Al6061 alloy/Sic/ MoS2

Hybrid metal matrix composites lead to the following conclusions:

1) The optical micrographs of hybrid composites produced by stir casting methodology shows that the Allocation of Silicon carbide and molybdenum disulfide particulates in the metal matrix is homogeneous.
2) The porosity of the test material increases with increase in vol. fraction of reinforced particles.
3) The SEM (Scanning Electron Micrographs) of the worn surfaces of the hybrid metal matrix composites shows the worn surface of the composite alloy is commonly much rougher than that of the strengthened alloy.
4) In XRD patterns, presence of MoS2and Sic is apparent in all aluminum alloy hybrid metal matrix composites.

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