AN INVESTIGATION ON THE TRIBOLOGICAL PROPERTIES OF OVER DEFORMED AL/SiCp COMPOSITES

M.Baki Karamış[1], F.Nazlı Sarı[2] , Veysel Erturun[3]

[1] Erciyes University,Department of Mechanical Engineering , 38039, Kayseri/TURKEY
email:karamisb@erciyes.edu.tr
[2] Erciyes University of Institue of Science and Technology, 38039, Kayseri/TURKEY
[3]Erciyes University, College of Aviation / Airframes and Powerplants 38039, Kayseri/TURKEY

Introduction

There are two methods to increase the mechanical properties of materials by obtaining ultra fine grain structure. These are severe plastic deformation (SPD) under recrystallization temperatures and powder metallurgy [1]. Many researches have been continued for obtaining the developed properties of aluminum based metal matrix composites (Al-MMC) in the world. These researches have been attempted to improve the microstructure, mechanical and tribological properties of Al-MMC via different deformation processes. Extrusion is one of the best methods of plastic deformation for improving the properties by eliminating pores in material structures [2]. By this study, tribological properties and micro structure of Al based composites reinforced by SiC were investigated. The main purpose of this study is to improve the plastic properties of Al-MMCs by over deformation by reciprocating extrusion process (RE). To obtain nonporous microstructure and improved plastic properties, the billets producing by powder metallurgy were extruded by RE applied in many cycles. A homogeneous dispersion of SiCp in Al matrix and nonporous microstructure were supplied by hot RE applied at 573º C.

Mass losses in dry sliding conditions were increased with load and sliding time. Under lubricated conditions, it was also observed the results resembling to that of dry conditions.

Experimental

Materials and MMC preparation

The materials used in this research were AA6061 alloy, AA6061 powder and SiC particles. SiC was used as reinforcement in the composites with volume fraction of 5%.

First the AA6061 powder (72 µm) was mixed with SiC (20µm) particles by hand then it was mixed by mechanic mixer for 1 hour. Then the mixed powder was hot pressed in argon atmosphere under 500Kpa at 888 ^{0}K .The billet dimensions were 30 mm in diameter with 50 mm length. Also AA6061 alloy billets were in the same dimensions.

Both compacted and alloy billets were extruded reciprocatingly in an extrusion press machine that was specially designed for this research. These billets were extruded at 573 ^{0}K under 17,5 Mpa with 0,1,5,9 and 15 passes. The extrusion ratio was 10:1.

0 pass means billets were inserted into container and then extruded into a rod with a diameter of 10 mm. Composite and AA6061 alloy specimen billets with 1,5,9 and 15 passes finally were extruded a rod shape with a diameter of 10 mm without the back pressure at the end of last pass.

All billets and extruded samples were tested for hardness. The hardness could be determined with Rockwell superficial N scale under 15 N load. The results are shown in Table 1.

Table 1
Hardness of the wear test samples
Hardness (HR15 N)

Passes	AA6061/SiC20μ/5	AA6061
Billet	23	23
Co	40,5	36,2
C1	42,1	22,5
C5	41,1	26,9
C9	39,1	16,2
C15	41,2	24,3

Wear tests

The wear tests were performed with pin-on-ring configuration. All tests were carried out at room temperature under dry and lubricated conditions. Wear samples with the size of 10 mm in diameter and 15 mm in length were used as the pin and the ORS6304 steel bearing material with hardness of 62 HRC was used as the counter face. Fig.1 represents wear test configuration.

While the samples were rotated by 500 rpm, the loads of 50, 75 and 100 N were applied separately for each tests. The frictional forces occurred during the test were recorded with a software compatible with testing machine. SAE10W40 oil was used as a lubricant for lubricated sliding. All tests were stopped when the friction distance reached 1225 m. Wear was evaluated on weight loss and frictional force of the samples.

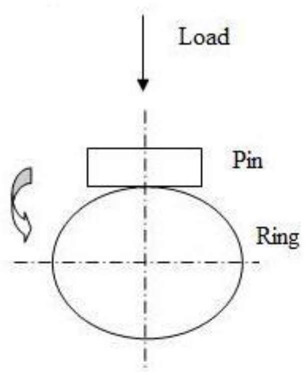

Fig.1. Wear test configuration

Before each tests, samples were mechanically polished and cleaned. The bearings materials used as ring were also cleaned. All wear test samples were weighed prior to and after each test. The surface roughnesses of all samples were also recorded before and after the tests.

Characterization of the worn material

After the wear tests, characterization of the worn surface were observed by the employing optical microscopy (OM) and scanning electron microscopy (SEM).

Results and Discussion

The magnitude of the total wear was measured as the loss in weight after the sliding distance of 1125 m for all the tested samples.

Conclusion

Tribological properties and micro structure of Al based composites reinforced by SiC were observed. Under dry conditions, the surface roughness of all samples is increased dramatically after wear tests. The weight losses of the samples tested under dry conditions are increased with load, while it is not affected by the load under lubricated conditions generally. By the increasing of RE cycles, the hardness of composites were nearly constant. The wear modes of the worn surfaces are generally abrasive for reinforced composites, while it is predominantly adhesive for AA6061 samples.

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