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Furnace Temperature Effect on Tribological Behavior of Metal Matrix Composites Produced By Plunger Technology

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Abstract

There is a growing attention among researchers to the production of new composites with low-density and low-cost processes. Aluminum based metal-matrix composites (AMMC) offer solutions for new product development. Plunger technology is the low cost high effectiveness method for production of Aluminum based metal-matrix composites (AMMC) by liquid route. Al-2Mg-10SiC composite was manufactured by plunger technology with weight percentage at different furnace temperature such as 700^0C, 800^0C, 900^0C. The samples are collected for dry sliding wire on "pin on disc" method and the results were analyzed.

Keywords: Aluminum metal matrix composites, Plunger Technique, dry sliding wire, wear rate.

1. INTRODUCTION:

Light weight and high performance composites are used for different industrial, automotive and aerospace applications. SiC particles are uniformly distributed in Al-Mg melt matrix using plunger technology [1-3,21-22]. Here plunger rods are used to incorporate uniformly the particles inside the melt. The most commonly used composite system with the metal matrix Aluminum-Mg alloy reinforced with silicon carbide prepared an aluminum-metal matrix composite through liquid route. Here the SiC particles are uniformly distributed in the Matrix melt which provides homogeneous mixture so that properties are uniform throughout [4-7]. An aluminum-alloy has excellent mechanical properties such as low density, higher thermal conductivity, strength to weight ratio, good ductility, and corrosion resistance, among others [8-9, 21-22]. Aluminum-alloys have high strength and are used in aeronautics as well as all automotive sectors. The addition of SiC to matrix aluminum improves strength and mechanical-thermal properties. The hard particles of SiC increase the strength of the composite so that its wire properties improve which is used for load sustaining components [10-11]. In the stir-casting method, the ceramic reinforcement, i.e., silicon carbide melted with aluminum metal-matrix, achieved improved properties of the composites [12-13]. All mechanical components that slide or roll, like brakes and clutches, bearings, piston rings, terrain, gears, guides,

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and seals, are exposed to wear[14-15]. The tribological behavior of the prepared composite was tested in dry sliding condition where the pin is made of the sample Al-1%Mg-10%SiC composites [16-20]. Dry sliding wire was conducted on pin-on-disc method to the samples of aluminium-1%Mg-silicon carbide manufactured at three furnace temperatures such as 700^0C, 800^0C, 900^0C. The wire rate was calculated for the Aluminum based metal-matrix composites (AMMC) and the wire properties are compared at different sliding distance.

2. EXPERIMENTAL PROCEDURE:

Aluminium-1%Mg-silicon carbide composite was manufactured by plunger technology which has been published elsewhere. Here plunger rods are used to introduce silicon carbide particle to the Al-Mg alloy melt and the composites are manufactured as per required composition. The furnace temperature has great influence on hardness and wear properties. Sliding wear is conducted in dry condition using Pin-On–Disc method where pin is the sample. The instrument used is DUCOM-PIN-ON-DISC apparatus as shown in Figure-1 and Figure-2. The pin (sample) and disk (EN31 steel) was cleaned by Emory paper so that smooth contact will take place between pin and disk. The test was conducted using the standard ASTM G-99 at room temperature. The mass loss of the sample made of prepared composite is calculated by measuring the initial mass and final mass using the weight balance. The wire rate is calculated using the formula 1.

Figure1- Sample and pin-on-disc wear-test apparatus for the wear-test.

The samples of size length 30mm and diameter 10mm was fitted as pin and EN31 steel was taken as disc. The dry sliding wire test was conducted at sliding velocity 2m/s and load 20N for different sliding distance such as 500m, 700m, 900m, 1100m, 1300m, 1500m. The wire rate was calculated as follows.

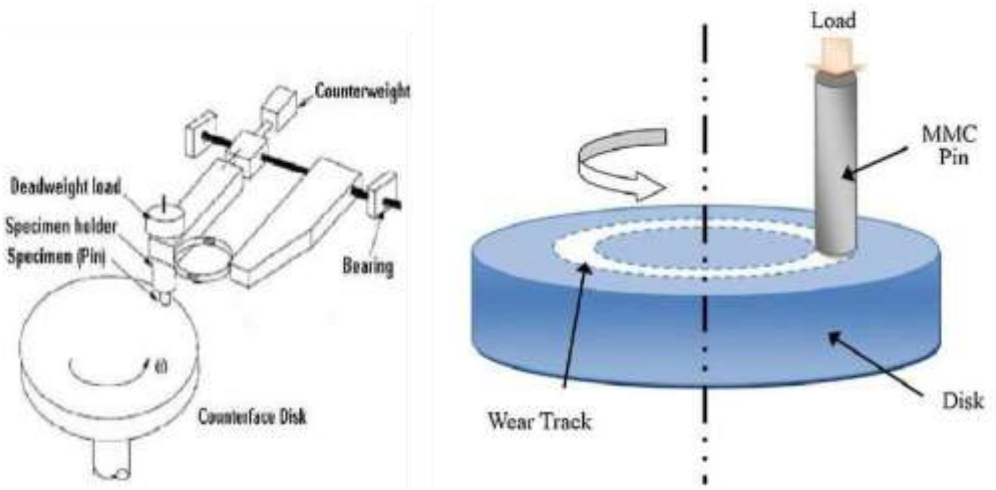

Figure 2- Spin-on-disk apparatus schematic diagram

The wear rate (W_r) of the materials were calculated by

$$Wr = \frac{\Delta w}{L\,\rho} \quad \text{In mm}^3\text{/m} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (1)$$

Where Δw= weight loss of the pin (AMMC) in mg.

L= sliding distance in meter

ρ = density of the AMMC in mg/mm^3

3. RESULT AND DISCUSSION:

The samples were tested for different sliding speed and the results are shown in three tables given below such as Table-I, Table-II and Table-III.

Table I: Furnace Temperature 700^{0}C, Load 20N, Sliding Speed 2 m/s.

Exp no	Sliding distance (L)	Wear rate(Wr)[mm3/m (× 10–3)]
1	500m	2.8632
2	700m	2.5691
3	900m	2.3326
4	1100m	2.1246
5	1300m	1.9984
6	1500m	1.7126

Table II: furnace temperature 800^{0}C, Load 20N, sliding speed 2m/s.

Exp no	Sliding distance	Wear rate [mm3/m (× 10–3)]
1	500m	2.7451
2	700m	2.4632
3	900m	2.2326
4	1100m	2.0359
5	1300m	1.8672
6	1500m	1.6111

Table III: Furnace Temperature 900^{0}C, Load 20N, Sliding Speed 2 m/s.

Exp no	Sliding distance	Wear rate [mm3/m (× 10–3)]
1	500m	2.9256
2	700m	2.6432
3	900m	2.3529
4	1100m	2.2228
5	1300m	2.0724
6	1500m	1.8999

The wire rate vs. sliding distance curve was shown in figure 3.

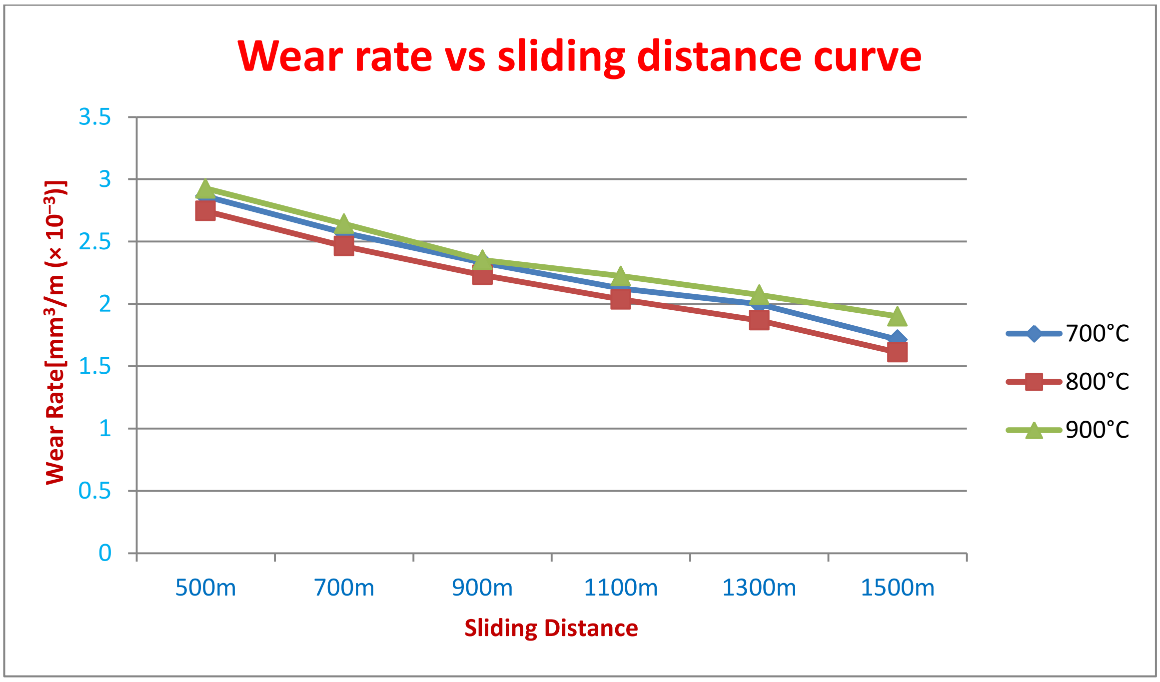

Figure 3- Graph for wire rate vs. Sliding Distance

4. CONCLUSION:

1. AMMC was produced successfully using plunger technology.
2. The product was manufactured at different temperature and tested for dry sliding wire which is highly useful in automobile industries.
3. The wire rate is much less as compared to the base metal aluminum.
4. The wire rate of the AMMC manufactured at 800^0C is less as compared to the manufactured at 700^0C and 900^0C.
5. The result may be standardized for industrial use.

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REFERENCE

[1] RK Behera, BP Samal, SC Panigrahi and KK Muduli. Microstructural and mechanical analysis of sintered powdered aluminium composites.Adv. Mater. Sci. Eng. 2020; 2020, 1893475.
[2] RK Behera,B PSamal andS C Panigrahi. Manufacture of die and their designing parameters for sintered AMC product. Mater. Tech. 2019; 107, 605.
[3] RK Behera, SC Panigrahi, BP Samal and PK Parida. Mechanical properties and micro-structural study of sintered aluminium metal matrix composites by P/M technique. J. Mod. Manuf. Syst. Tech. 2019; 3, 089-097.
[4] A Mazahery andMO Shabani.Study on microstructure and abrasive wear behavior of sintered Al matrix composites. Ceram. Int. 2012; 38, 4263-9.
[5] C Garcla-Cordovilla, J Narciso andE Louis.Abrasive wear resistance of aluminium alloy/ceramic particulate composites. Wear 1996; 192, 170-7.
[6] BP Samal, AK Misra, SC Panigrahiand Sc Mishra. A Novel technique for improved recovery of Mg--Analysis of the microstructure and physical properties. J. Mater. Metall. Eng. 2013;3, 1-7.
[7] S Banthia, S Sengupta, S Das and K Das. Cu, Cu-SiC functionally graded coating for protection against corrosion and wear. Surf. Coat. Tech. 2019; 374, 833-44.
[8] J Sethi, S Das andK Das. Development of low expansion and high strength aluminum matrix hybrid composite. In: A Ratvik (Ed.). Light metals. The minerals, metals & materials series. Springer, Cham, 2017, p.187-93.
[9] A Mandal, K Das andS Das.Characterization of microstructure and properties of Al-Al3Zr-Al2O3 composite. Bull. Mater. Sci. 2016; 39, 913-24.
[10] AK Pradhan and S Das.Dry sliding wear and friction behavior of Cu-SiCnanocomposite coating prepared by pulse reverse electrodeposition. Tribol. Trans. 2014; 57, 46-56.
[11] S Das, K Das and SDas.Abrasive wear behavior of Al-4.5 wt%Cu/(Zircon Sand + Silicon Carbide) hybrid composite. J. Compos.Mater. 2009; 43, 2665-72.
[12] SC Lim, M Gupta, L Renet and JKM Kwokb.The tribological properties of Al-Cu/SiCp metal- matrix composites fabricated using the rheocasting technique. J. Mater. Process. Tech. 1999; 89-90, 591-6.
[13] G Dixit andMM Khan.Sliding wear response of an aluminium metal matrix composite: Effect of solid lubricant particle size. Jordan J. Mech. Indus. Eng. 2014; 8,351-8.
[14] S Basavarajappa, G Chandramohan, R Subramanian and A Chandrasekar. Dry sliding wear behaviour of Al 2219/SiC metal matrix composites. Mater. Sci-Poland 2006; 24, 358-66.
[15] S Ghosh, P Sahoo andG Sutradhar. Wear behaviour of Al-SiCpmetal matrix composites

and optimization using Taguchi method and grey relational analysis. J. Miner. Mater. Char. Eng. 2011; 11, 1085-94.

[16] M Uzkut. Abrasive wear behavior of SiCp-reinforced 2011 Al-alloy composites. Mater. Tech. 2013; 47, 635-8.

[17] M Narayan, MK Surappa and BNP Bai. Dry sliding wear of Al alloy 2024-Al2O3 particle metal matrix composites. Wear 1995; 181-183, 563-70.

[18] BG Park, AG Crosky and AK Hellier. Material characterization and mechanical properties of Al2O3-Al metal matrix composites. J. Mater. Sci. 2001; 36, 2417-26.

[19] BK Prasad.Investigation into sliding wear performance of zinc-based alloy reinforced with SiC particles in dry and lubricated conditions.Wear 2007; 262, 262-73.

[20] J Salguero, J Manuel, SV Martinez and Batista. Application of pin-on-disc techniques for the study of tribological interferences in the dry machining of A92024-T3 (Al-Cu) alloys. Materials 2018 ; 11, 1236.

[21] B.P.Samal, P.K.Das, R.K.Mallik, Experimental investigation of Magnesium recovery and Tensile properties of Alloys made of Aluminum-Magnesium with variation of temperature in the furnace using Plunger Technique,IJIRE,Volume-3,Issue-4, (2022),PP:123-126.

[22] B.P.Samal, S.P.Jena,S.Sahoo,S.Swain R.K.Mallik, Production and characterisation of Al-Mg-SiC particulate composites at different furnace temperature through liquid route using Plunger Technique, IRJIET, Volume-6,Issue-7, (2022).