Conference Paper

Mechanical Properties of Metal Al/SiC and AlCu/SiC Metal Matrix Composites (MMCs)

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Abstract

The Metal Matrix Composite (MMCs) Al/SiC and AlCu/SiC through steering hot method have been done. The SEM images show that there are microstructure differences between the Al/SiC and AlCu/SiC. Tensile test results show the value of the yield stress of AlCu /SiC higher than Al/SiC. Meanwhile, the testing of wear resistance during 50 minutes earned the mass lost on Al/SiC 4.7% while AlCu/SiC 7.32%. We believed that the addition SiC particle can improve the mechanical properties and reduces the frictional resistance.

Keywords: Hot steering Al/SiC, AlCu/SiC, tensile test, wear resistance

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1. Introduction

To date composite materials is potential to be developed due to their superiority in mechanical properties[1]. There are four typical engineered composite materials such as composite building, reinforce plastics, metal composite, ceramic composite. Metal matrix composites has excellent mechanical properties, such as strength, modulus of elasticity, toughness, impact resistance, electrical conductivity and high heat [2]. Metal matrix composites (MMCs) reinforced with ceramic particles are promising materials for structural applications due to excellent combination properties. The matrix ussualy light metal such as copper (Cu), magnesium (Mg) and aluminum (Al) which the reinforcement embedded [3]. Among these matrix, Al matrix composites posses low density, high stiffness and strength, superior wear resistance, controlled coefficient of thermal expansion, higher fatigue resistance and better stability at elevated temperature [4]. Therefore, these composites are used for the design of a wide range of components for advanced applications [5].

Preparation methods of metal-based composite materials have been demonstrated such as powder metallurgy, ppressure infiltration mmethod, single compaction, and laser powder deposition have been developed [5]. In this paper, we report Al matrix and AlCu composites reinforced with silicon carbide (SiC) particle. It's believed that the hardness and meling point will improve significantly [6-10]. Microstructure and mechanical properties of Al/SiC and AlCu/SiC were characterized systematical.

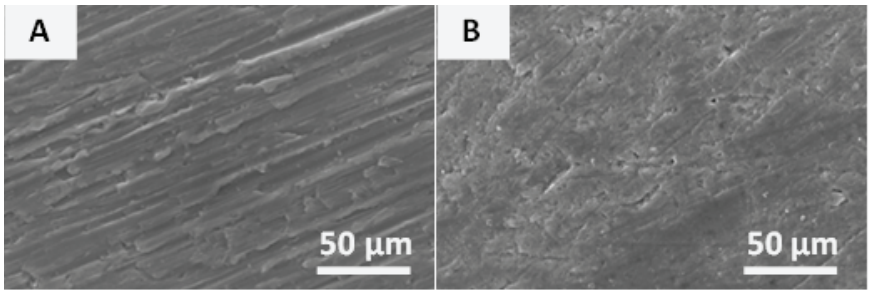

Figure 1: SEM images of (A) surfaces of Al/SiC and, (B) AlCu/SiC composites.

2. Experiment Method

The Al and Al+Cu (3.8 wt.%) were prepared through melting processes. The SiC (2 wt.%) as a ceramic particleshaving a size range of 0.4 to 1 mm. Then, Al and Al+Cu mixed with SiC particles. The stirring process (200 rpm) was performed during heating at temperature 900°C. After the stirring process, the crucible was taken from the furnace and the composites were poured into a metallic mold. After the cast composites were prepared, the heating process under melting temperature (annealing) at 400°C for 6 hours was performed in order to optimize the microstructure.

3. Results and Discussion

3.1. Morphology

Figure 1 show the SEM images of the surface of Al/SiC andd AlCu/SiC. The images indicate that the grain matrix composite of Al/SiC and AlCu/SiC not clearly formed. Nevertheless, The Al/SiC look more solid than the AlCu/SiC. The presence of each phase SiC as much as 2% can be identified by the existence of grain boundaries.

3.2. Tensile Test

The process of measuring the tensile test carried out on material Al, Al/SiC, AlCu and AlCu/SiC. All compositions stress-strain of the samples can be seen in Figure 2.

The value of tensile test results in the form of maximum stress, yield stress and maximum force can be seen in the Table 1. The amount of stress before plastic deformation (yield stress) relates to the value of maximum stress possessed by each composition. For AlCu, the value of the yield stress was not detected. It is due to the small area of the plastic material and AlCu is a brittle material.

3.3. Wear Resistance Test

The wear resistance testing was performed to the material Al, Al/SiC, AlCu and AlCu /SiC with the size dimensions of the rectangle (Table 1) and the broad surface average

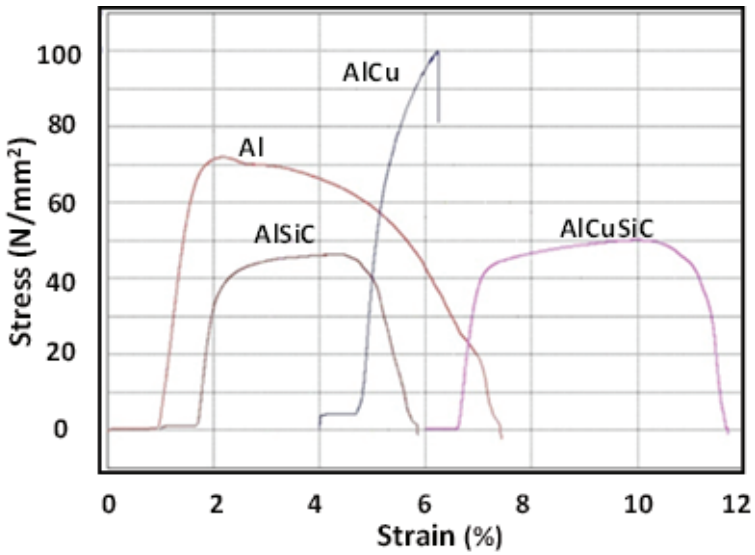

Figure 2: Stress-strain relationship of Al, Al/SiC, AlCu, and AlCu/SiC obtained from tensile test results.

Materials	Stress Max (N/mm^2)	Yield stress (N/mm^2)	Force max (N)
Al	71.894	67.335	509.426
Al-SiC	46.236	43.688	397.228
Al-Cu	100.247	-	778.551
Al-Cu-SiC	50.048	49.417	415.715

Table 1: The maximum stress, yield stress, and maximum force of Al, Al/SiC, AlCu, and AlCu/SiC.

of each sample was 48.07 mm^2. The results show that all samples have mass reduction after friction on sample surface (after the process for 50 minutes).

In Figure 3 graphics percentage mass loss against time for material Al, Al/SiC, AlCu, and AlCu /SiC. The overall mass of the sample decreased linearly due to the friction. Linear mass loss for all samples showed that the synthesized samples have homogeneity.

The results of wear resistance test confirmed that the sample Al and Al/SiC have mass loss linearly and the mechanical properties improvement by addition of SiC (2 wt. %) (table 3). Furthermore, the mechanical properties of Al improved after combined with Cu as much as 3.8%. Meanwhile, the mechanical properties were decreased after SiC added.

Materials (Composition)	Length (mm)	Width (mm)	Thickness (mm)
Al	9.60	5.30	1.55
Al-SiC	9.00	5.60	1.63
Al-Cu	9.40	5.30	1.60
Al-Cu-SiC	8.60	5.30	1.60

Table 2: Samples size of Al, Al/SiC, AlCu, dan AlCu/SiC.

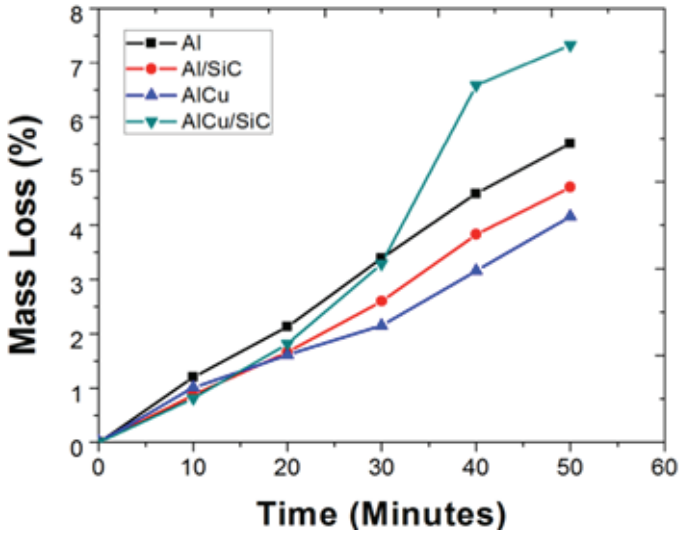

Figure 3: Percentage of mass loss of Al, Al/SiCp, AlCu, dan AlCu/SiCp.

No	Time (minutes)	Al		AlCu		Al/SiC		Al-Cu/SiC	
		Mass (gr)	Mass Lost (% wt)	Mass (gr)	Mass Lost (% wt)	Mass (gr)	Mass Lost (% wt)	Mass (gr)	Mass Lost (% wt)
1	0	0.1505	0	0.1489	0	0.1384	0	0.1489	0
2	10	0.1486	1.20	0.1474	1.01	0.1372	0.87	0.1477	0.81
3	20	0.1472	2.13	0.1465	1.61	0.1361	1.66	0.1462	1.81
4	30	0.1453	3.39	0.1457	2.15	0.1348	2.60	0.1440	3.29
5	40	0.1435	4.58	0.1442	3.16	0.1331	3.83	0.1391	6.58
6	50	0.1421	5.51	0.1427	4.16	0.1319	4.70	0.1380	7.32

Table 3: The mass values of composite material Al, Al/SiC, AlCu, dan AlCu/SiC.

4. Conclusions

In conclusions, the Al matrix and AlCu composites reinforced with silicon carbide (SiC) particle have been demonstratedd by steering at 900°C. Tensile test shows the value of the yield stress of AlCu/SiC higher than Al/SiC. Testing of wear resistance during 50 minutes earned the mass lost on Al/SiC 4.7% while AlCu/SiC 7.32%.

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