ScienceDirect

Materials Today: Proceedings

Volume 68, Part 5, 2022, Pages 1422-1428

Study the enhanced mechanical properties of Al/B4C metal matrix composite

A. Abhishek Krishna Sai, M. Chandrasekaran, T. Vinod Kumar, R. Pugazhenthi

Show more

Share Cite

https://doi.org/10.1016/j.matpr.2022.06.465

Get rights and content

Highlights

- This article is focussed to study the behaviour of Al7010 alloy with reinforcement of Boron carbide (B_4C) mechanical and wear behaviour in dry sliding conditions with sliding speed of 0.6 m/s for a distance of 1200 m, with loads of 25 and 50 N at the room temperature.
- The flux K2TiF6 was used to address in composites with 5–20vol% B_4C, the wetting problem between AA7010 and B4C, which aids in the development of undesirable phases at interfaces.

Abstract

The purpose of this study is to see how Boron carbide (B_4C) reinforcement affects the mechanical and wear behaviour of Al7010 alloy in dry sliding conditions at room temperature. The liquid casting method was used to create the aluminium 7010 with

B_4C metal matrix composites. The flux K2TiF6 was used to address in composites with 5–20vol% B_4C, the wetting problem between AA7010 and B_4C, which aids in the development of undesirable phases at interfaces. A pin on disc equipment was used to conduct wear tests on AA7010- composites against an OHNS disc. The wear tests were carried out at a sliding speed of 0.6m/s, a distance of 1200m, and loads of 25 and 50N. The wear resistance of AA 7010 –B_4C composites was found to be superior to that of the base alloy. After a short sliding distance, the coefficient of friction achieved a steady-state value. The composites' wear rate and coefficient of friction are significantly reduced when compared to base alloy, and it reaches its lowest value at 10vol% B_4C under all load conditions. The coefficient of friction reduces as the sliding distance rises. The B_4C reinforced AA7010 composites had good wear resistance, with 10vol% B_4C being the best for achieving the lowest wear rate under all load circumstances. The composites' hardness and tensile strength improve as the B_4C level rises. SEM photos were used to examine the microstructures of the worn surfaces.

.

Introduction

Composite materials are often employed in dry friction and wear applications such as dry friction and wear because they improve the materials' tribologcal performance. In industrial applications, metal-based composites such as aluminium alloy is widely selected as matrix [1]. The fundamental reason for using aluminium as the matrix is because it has a lower density while also having higher wear resistance, hardness, stiffness, and tensile strength. Powder metallurgy, mechanical alloying, squeeze casting, compo casting, and stir casting, among other processes, were used to create aluminium metal matrix composites (AMCs) [2], [3]. The most effective process among the several alternatives was liquid casting, which involves adding ceramic particles to molten metal. The liquid casting technology stood out for its simplicity, ease of execution, and mass production, among other things. The type, size, shape, mass or volume proportion, and spatial distribution of ceramic particles in the aluminium matrix determine the AMCs. [4]. The fabrication procedure has the greatest impact on bonding strength.

According to studies [5], [6], [7], [8], the abrasive wear conditions of particle reinforced MMCs at both high and low-stress increase with the volume (quantity) fraction of particles. Increasing the hardness of a substance enhances its wear resistance, according to several research [9], [10]. According to studies [5], [6], [7], [8], the abrasive wear conditions of particle reinforced MMCs at both high and low-stress increase with the volume (quantity) fraction of particles. Several studies have discovered that increasing the hardness of a substance improves its wear resistance according to reports, the COF value for steel and B_4C is significantly lower than the COF value for aluminium alloys and steel. The introduction of B_4C particles to strengthen the composite resulted in an improvement in the composite's wear behaviour, as stated above. [11]. B_4C has been used in particle reinforced MMCs [11], [12], [13], [14] and reduces the wear rate of the composite with a rise in vol percent B4C of the numerous reinforcing materials available. B_4C looks to be tougher and less dense than SiC and Al2O3 when compared. [15]. B4C ceramics are known for their wear-resistant materials, electrode materials, neutron absorption materials, cutting tools, and electrode materials, in addition to qualities such as high hardness, high melting point, and strong electrical and thermal properties [16].

The major challenge is to control the undesired interface reaction between B_4C and Al matrix during the production of AlB_2 and Al_4C_3 formed on the surface of B_4C, which causes its decomposition. This causes a decrease in the fluidity of the melt and as well as a deterioration of its properties. Whereas, when titanium is added to aluminium, a protective layer consisting of TiB_2 and TiC is formed over the particle surface. Studies relating to aluminium MMC's reinforced with B_4C particles are scarce and few [17]. Al-B_4C composites are used as neutron absorbers in nuclear power plants [18], [19], [20]. The goal of this research is to find out how AA7010 reinforced with B4C composites wears and what mechanical properties they have when sliding in dry conditions.

Section snippets

Materials and methods

The matrix was chosen from a commercially available 7010 aluminium alloy with the chemical makeup indicated in Table 1. B_4C was chosen as the reinforcement because it has an average particle size of 16–20m and is 99 percent pure powder. Boron Carbide India Ltd, Mumbai, was the source of B_4C. All of the materials were purchased and used just as they were, with no modifications or distillation.

B_4C volume fractions were calculated to be 5, 10, 15, and 20%. The composite was made in a 1.0 kg melt…

Density

The density of the composites was calculated according to Archimedes' principle. Distilled water was used as the immersion fluid and the respective density was shown in Fig. 2. The composite had a lower density than the base alloy and was sealed with a B_4C composition of 5% by volume. The density decreases with increasing B_4C content.…

Hardness

Fig. 3 depicts the hardness value of T6 aged Al 7010 and composites. The composites with varied percentages of B_4C had higher average hardness values than the base …

Conclusion

Based on the research work carried out the following conclusions are derived. The composite Al7010-B4C was successfully manufactured with the addition of K2TiF6 flux using the liquid casting technique. The casted Al7010-B4C composites have greater hardness and tensile strength than the base alloy.

- The composite's wear rate lowers considerably as the B_4C content increases, and it reaches its lowest wear rate at 10 vol% B_4C in all stress circumstances.…
- With increasing B_4C content, the coefficient…

…

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.…

Special issue articles   Recommended articles

References (23)

D.Z. Wang *et al.*
Wear (1995)

T.P.D. Rajan *et al.*
Compos. Sci. Technol. (2007)

A.P. Sannino *et al.*
Wear (1995)

S.V. Prasad *et al.*
Mater. Sci. Eng. (1986)

R. Pugazhenthi *et al.*
Mater. Today: Proc. (2020)

A.R. Kennedy *et al.*
Scripta Mater. (2001)

H.M. Hu *et al.*
Mater. Sci. Eng. A (2001)

H. Zhang *et al.*
Mater. Sci. Eng. A (2004)

A. Rajasekaran *et al.*
Mater. Today: Proc. (2020)

A. Perumal *et al.*
Mater. Today: Proc. (2021)

View more references

Cited by (2)

Additive manufacturing of B4C-W-based composites via fused deposition molding using highly filled granular feedstocks ↗

2023, International Journal of Applied Ceramic Technology

Experimental Analysis of the Mechanical and Machining Properties of an Aluminium Hybrid Metal Matrix Composite ↗

2023, Key Engineering Materials

View full text