Trans Indian Inst Met (2024) 77(9):2761–2775
https://doi.org/10.1007/s12666-024-03370-4

ORIGINAL ARTICLE

Microstructural Evolution and Wear Dynamics of Al5052/Cenosphere Metal Matrix Composite Fabricated Through Compo-Casting Technique

Khursheed Ahmad Sheikh[1] · Fayaz Ahmad Mir[1]

Received: 13 March 2024 / Accepted: 21 May 2024 / Published online: 9 June 2024

Abstract The present study uses the compo-casting technique to fabricate cenosphere-reinforced Al5052 alloy. The wear tests were performed utilizing a pin-on-disk apparatus to examine the impact of load, sliding speed, and reinforcement wt.% on the wear rate. Employing response surface methodology (RSM), this research delves into the influences of load, sliding speed, and cenosphere content on the responses. As per the ANOVA analysis, load exhibited the most substantial effect. The ramp plots unveiled the optimal combination for minimizing wear rate identified as 200 rpm sliding speed, 10 N load, and 0 wt.% cenosphere reinforcement. The desirability plots reveal that the prediction value for wear rate is 0.7695 mm^3/Nm at a desirability of 96.8%. Incorporating cenosphere particles as reinforcement increased the wear resistance of the aluminum metal matrix composites (AMMCs).

Keywords Al5052 alloy · Compo-casting technique · Sliding wear · RSM

1 Introduction

Aluminum, possessing a lustrous, silver-white appearance, exhibits similar characteristics to other non-ferrous metals. Its highest level of functionality is attained by blending it with trace amounts of other metals, thereby boosting its strength and resilience without compromising its lightweight property. Moreover, alloying aluminum renders it exceptionally easy to machine [1]. The primary additive in aluminum 5052 (Al5052) alloy, belonging to the 5xxx series, is magnesium. Al5052 is classified as a non-heat treatable alloy and undergoes cold working processes to improve its strength. With remarkable properties and heightened fatigue resistance, Al5052 alloy is commonly utilized in structures subjected to repetitive vibrations [2]. The popularity of aluminum-based composites has surged owing to their remarkable strength and elevated modulus. These composites exhibit outstanding resistance to wear, a low coefficient of thermal expansion, resilience to high temperatures, and a notable capacity for damping [3]. Industries like automotive, aerospace, and marine are favoring advanced lightweight materials. AMMCs, with properties like durability and wear resistance, are set to meet industry demands. These composites can include various reinforcements for versatility [4, 5].

Metal matrix composites (MMCs) stand out as a promising category of materials due to their unique properties. While AMMCs offer a broad spectrum of reinforcement possibilities, their performance in tribological applications is impeded by their low hardness and limited wear resistance [6]. Optimal qualities and performance of metal matrix composites (MMCs) are achieved through meticulous selection of the reinforcing phase and careful consideration of processing techniques and parameters [7]. The utilization of aluminum metal matrix composites is on the rise across diverse technological applications, including vehicle pistons, and bicycle frames. These composites are appealing for a range of technical uses owing to their blend of high strength and exceptional corrosion resistance [8]. Zhiqiang et al. [9] examined the sliding wear characteristics of aluminum matrix composites reinforced with silicon. The results indicate that the composite exhibited a lower degree of weight reduction in comparison to the matrix alloy. Rao et al. [10] found that the wear rate of Al-Zn-Mg alloy composites

✉ Fayaz Ahmad Mir
Fayaz_07phd19@nitsri.ac.in

[1] Department of Mechanical Engineering, National Institute of Technology Srinagar, Srinagar, India