MICROSTRUCTURAL AND MECHANICAL INVESTIGATIONS OF BORON NITRIDE REINFORCED ALUMINUM 356 COMPOSITES PRODUCED BY THE CASTING METHOD

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Keywords: Aluminum, casting, BN, composite, microstructure, mechanical investigation

ABSTRACT

In this study, aluminum-based composites reinforced with nano-sized boron nitride (BN) were produced by using the casting method. Particle sizes of BN were reduced down to nanoscale via milling for 96 h at room temperature. The casting process ensured a homogeneous distribution of BN within the alloy matrix by melting the aluminum alloy, introducing BN powders under optimal conditions, and solidifying the mixture in molds. Microstructural analyses were conducted to assess phase structure, grain size, and BN dispersion by XRD, OM, SEM, and SEM-EDX techniques, while mechanical properties of composites were evaluated through microhardness tests. Results showed significant improvements in alloy properties, highlighting the potential of these composites as lightweight, durable materials for aerospace and automotive applications.

1. INTRODUCTION

A356 aluminum alloy is widely used in aerospace and automotive industries due to its high strength-to-weight ratio, corrosion resistance, and good castability [1]. However, the coarse eutectic silicon structures and α-Al dendrites in the as-cast form negatively impact mechanical properties. To overcome these limitations, reinforcement techniques are employed [2]. Boron nitride (BN), known for its high thermal stability and chemical inertness, has been utilized to enhance wear resistance and microstructural stability. However, its low wettability in molten aluminum presents challenges in achieving a uniform dispersion [3,4]. This study focuses on BN reinforcement in A356 aluminum alloy, with homogeneous distribution of BN distribution and improve the mechanical properties and microstructural features produced samples.

2. MATERIALS AND METHODS

A356 aluminum alloy was melted at 750 °C to ensure the optimal fluidity in NRS induction furnace. BN powders were preheated to enhance wettability and subsequently added to the melt prior to the casting process, while the molten alloy was stirred to ensure a homogeneous distribution of the BN powders.

Table 1. Chemical compositions of Aluminum based composites.

Sample	A356 Composition (wt%)	BN Addition (wt%)
ABN	100	0
ABN1	99	1
ABN4	96	4

Moreover, the BN powders were also milled for 96 hours, and the particle size distribution were detected by Dynamic Ligh Scattering (DLS). The molten composite was then poured into molds and solidified for further analysis. To examine the microstructural and mechanical effects of BN reinforcement, X-ray diffraction (XRD) was employed to identify phases and crystallinity, while optical microscopy (OM) and scanning electron microscopy (SEM) were used to evaluate grain morphology and BN dispersion. Additionally, microhardness testing was conducted to determine the impact of BN on mechanical properties.

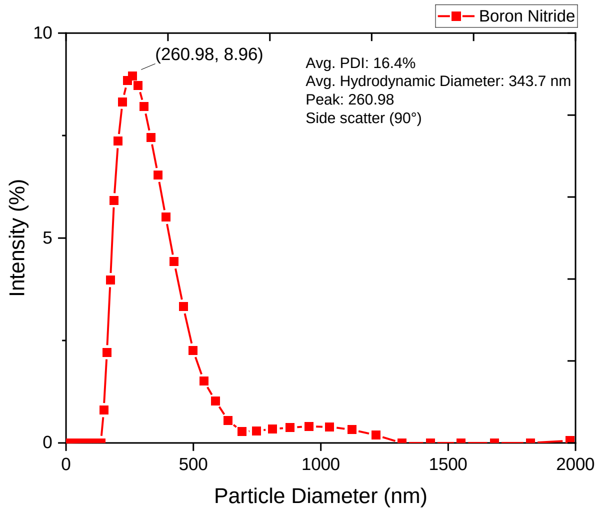

Figure 1. The particle size distribution of BN particles after 96 hours milling process.

3. CONCLUSION

BN addition to A356 alloy significantly enhanced hardness, and microstructural stability. The uniform grain refinement achieved through optimized processing techniques suggests that BN-reinforced A356 composites hold potential for aerospace and automotive applications.

Acknowledgements

This research did not receive any specific grant from funding agencies in the public, commercial, or non-profit sectors.

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