

Chapter 9

Ultrafine Grain Refinement and Improved Mechanical Strength of Compositionally Modified AZ 61 Alloy Composite

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ABSTRACT

The objective of this book chapter was to examine the changes in microstructure and mechanical properties of a modified AZ-61 composite with minor additions of scandium (0.2wt. %), calcium (0.5wt. %), and manganese (0.5wt. %) prepared

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using the stir casting method. The solidified ingots undergo thermal treatments, including ice water quenching, and age hardening for 2 hours at temperatures of 100 °C, 200 °C, 300 °C, and 400 °C. The results found that average grain size of an AZ61-Graphene (1wt.%) composite was measured to be 7.92 μm after aging at 100°C, 5.31 μm at 200°C, and 6.86 μm at 400°C. The addition of 1wt. % graphene to the AZ61 composite results in a favourable balance between strength and ductility. The inclusion of graphene in the modified AZ 61 composite results in a significant change in grain size and fine structure, leading to increased strength.

1. INTRODUCTION

In recent decades, researchers and manufacturers all over the globe have been more interested in alloys which based on lightweight, low density, great heat dissipation, and high damping capability. These desirable qualities have led to magnesium alloy's widespread use in automobiles, aerospace and other fields. The main purpose of the research is to enhance the mechanical properties of magnesium alloy, including enhancements to its tensile strength, hardness, and ductility (Song, J, 2020). The tensile strength of Mg alloys is relatively low compared to Al alloys or steels, despite of the dominant specific strength. Strain hardening and grain boundaries strengthening are two of the most common types of general strengthening mechanisms, along with precipitation, second phase and solid solution (You, S, 2017). When it comes to structure application, lightweight materials are an ideal solution since they have the potential to improve the fuel efficiency of vehicles while also lowering their emissions of carbon dioxide. This is accomplished by bringing down the overall mass of the vehicles. The enhanced efficiency results in lower consumption of gasoline. Magnesium and aluminium are two metals that have almost comparable melting temperatures as well as strengths. Because magnesium has an HCP structure, its ductility is significantly lower than that of aluminium, which has an FCC structure and is, therefore, more ductile. Because of this, the research and development of novel Mg alloy with enhanced mechanical characteristics is essential (Xu, T., 2019; Karakulak, E, 2019).

Studies on magnesium alloys have shown that the inclusion of rare earth significantly weakens the basal texture, activates non-basal slip mechanisms, and regulates grain size (Dong, X., 2021). On the other hand, RE components are uncommon and expensive. Commercial uses of Mg alloys incorporating RE elements are severely hampered by this issue. Mg-Zn-Ca alloys have very popular due to their specific properties. The effects of the inexpensive Ca elements are comparable to those of the RE essentials in Mg alloys. Ca is mixed to Mg-Zn alloys to increase their castability and creep resistance (M, R., & P, S, 2021).

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