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Effect of Nanoparticle on Microstructure and Mechanical Properties of Aluminum Alloy for Vehicles

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Extended Abstract

Nanotechnology has paramount importance in metallurgy, to meet the future demands of light-weight and durable materials. Recently, nano-materials are added to improve the mechanical and functional properties of alloys like aluminium, solder and so on [1-3]. Among light metals, aluminium is most popular one which is applicable to the transportation system like vehicle parts including internal combustion engine and electric cars [4]. For the internal combustion car, aluminium parts are adopted to improve fuel efficiency. In electric vehicle, to enhance mechanical property for thinner structural frame and battery efficiency, light aluminium alloys with higher strength are used for car frames and battery case [5].

It is reported that composite alloys with nano-material exhibit improved metallurgical and mechanical properties in optimal content of nano-materials [6]. Similar results are obtained in the bonding alloys. The nanoparticles dispersion and formation of intermetallic compounds (IMC) at the matrix and joint interface controls the reliability of Al-alloys. The excess growth of IMC in alloy might seriously impair the mechanical property. The addition of nanoparticles in aluminium alloys refines the microstructure, suppresses the IMC, prevents the dislocation and grain boundary movement, thereby improving their mechanical property. It is essential to investigate the effect of nanoparticle types and their optimum amount to obtain the best mechanical properties.

To improve metallurgical and mechanical properties of Al-alloy, in the present work, the effect of AlN nanoparticles and their optimum amount in Al-Si-Cu (A4047 with 19%Cu) alloy are investigated. The nanocomposite Al-Si-Cu alloys were prepared using liquid metal casting technique. The microstructure and IMC of nanocomposite Al-Si-Cu alloy have been observed by scanning electron microscope. The wettability is characterized from spreading test. Addition of AlN nanoparticles refined the primary Si and $CuAl_2$ IMC until an optimum amount of 0.10 wt.%, which is attributed to the adsorption theory of nano-sized AlN powders on the surface of Si and IMCs. The melting temperature decreased from 528 °C to 525 °C for 0.10 wt.%. The spreading ratio increased from 75% to 77% for 0.1 wt.% AlN addition in A4047 with 19%Cu alloy. Furthermore, 0.10 wt% AlN-reinforced A4047 with 19%Cu showed 16% improvement in tensile strength compared to the monolithic alloy. Agglomeration of nanoparticles at higher addition presumably decreased the spreading ratio and mechanical properties.

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