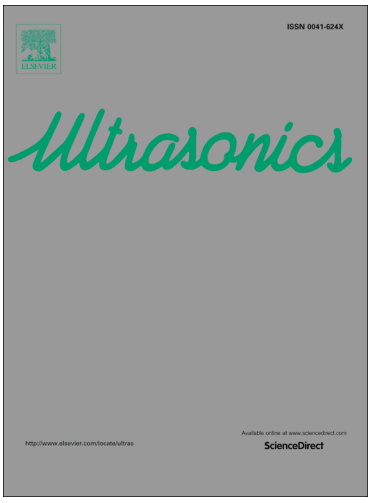

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PII: S0041-624X(17)30120-8
DOI: http://dx.doi.org/10.1016/j.ultras.2017.06.023
Reference: ULTRAS 5572

To appear in: *Ultrasonics*

Received Date: 20 February 2017
Revised Date: 23 June 2017
Accepted Date: 30 June 2017

Please cite this article as: Y. Xuan, L. Nastac, The Role of Ultrasonic Cavitation in Refining the Microstructure of Aluminum Based Nanocomposites during the Solidification Process, *Ultrasonics* (2017), doi: http://dx.doi.org/10.1016/j.ultras.2017.06.023

The Role of Ultrasonic Cavitation in Refining the Microstructure of Aluminum Based Nanocomposites during the Solidification Process

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Abstract

Recent studies showed that the microstructure and mechanical properties of aluminum based nanocomposites can be significantly improved when ultrasonic cavitation and solidification processing is used. This is because ultrasonic cavitation processing plays an important role not only in degassing and dispersion of the nanoparticles, but also in breaking up the dendritic grains and refining the as-cast microstructure.

In the present study, A356 alloy and Al_2O_3 nanoparticles are used as the matrix alloy and the reinforcement, respectively. Nanoparticles were added into the molten A356 alloy and dispersed via ultrasonic cavitation processing. Ultrasonic cavitation was applied over various temperature ranges during molten alloy cooling and solidification to investigate the grain structure formation and the nanoparticle dispersion behavior. Optical Microscopy and Scanning Electron Microscopy were used to investigate in detail the differences in the microstructure characteristics and the nanoparticle distribution. Experimental results indicated that the ultrasonic cavitation processing and Al_2O_3 nanoparticles play an important role for microstructure refinement. In addition, it was shown in this study that the Al_2O_3 nanoparticles modified the eutectic phase.

Keywords: Ultrasonic cavitation processing; Solidification processing; A356-matrix-nanocomposites; Al_2O_3 nanoparticles; Microstructure; Grain refinement; Eutectic modification.

1. Introduction

As a result of the high specific strength, high wear resistance, controllable expansion coefficient and economic efficiency, aluminum metal matrix composites (MMCs) have been treated as suitable materials in automobile, aerospace and military applications [1-8]. However, the micro-size ceramic particles, which were used as reinforcement in MMCs, could significantly decrease the ductility of these composite materials. It has been recently proven that using nano-size ceramic particles as reinforcement to fabricate metal-matrix-nano-composites (MMNCs) can distinctly improve the matrix properties, while maintaining good ductility and high temperature creep resistance [9-13]. The fabrication of high-quality MMNCs depends on the uniform dispersion of the nano-size ceramic particles into the matrix.