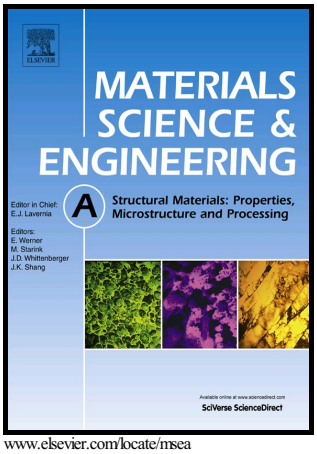
Effect of Carbon Nanotubes and high temperature extrusion on the microstructure evolution of Al-Cu alloy

Chunhong Li, Risheng Qiu, Baifeng Luan, Zhiqiang Li



www.elsevier.com/locate/msea

PII: S0921-5093(17)30820-1
DOI: http://dx.doi.org/10.1016/j.msea.2017.06.055
Reference: MSA35193

To appear in: *Materials Science & Engineering A*

Received date: 26 April 2017
Revised date: 12 June 2017
Accepted date: 13 June 2017

Cite this article as: Chunhong Li, Risheng Qiu, Baifeng Luan and Zhiqiang Li Effect of Carbon Nanotubes and high temperature extrusion on the microstructure evolution of Al-Cu alloy, *Materials Science & Engineering A* http://dx.doi.org/10.1016/j.msea.2017.06.055

Effect of Carbon Nanotubes and high temperature extrusion on the microstructure evolution of Al-Cu alloy

Chunhong Li[a,b], Risheng Qiu[a*], Baifeng Luan[a*], Zhiqiang Li[c]

[a]College of Materials Science and Engineering, Chongqing University, Chongqing 400044, China

[b]College of Metallurgy and Materials Engineering, Chongqing University of Science and Technology, Chongqing 401331, China

[c]College of Materials Science and Engineering, Shanghai Jiaotong University, Shanghai 200240, China

rsqiu@cqu.edu.cn

bfluan@cqu.edu.cn

[*]Corresponding author. Tel.: +86 23 65106067.

Abstract

CNTs/Al composites were prepared using flake powder metallurgy. The effects of CNTs and high temperature extrusion on mechanical properties and density of the material were investigated through analyzing crystal size, distribution and the change (size, chemistry and crystal structure) of precipitates and CNTs. Results show that hardness and density of the composites can be increased via extrusion and CNTs addition. Moreover, extrusion leads to refined precipitates with uniform distribution and partial dissolution compared to the as-sintered. The grains become smaller after addition of CNTs. Four types of phases distributed homogeneously in CNTs/Al composites: CNTs, Al_2Cu, Al_2O_3 and nano-sized Al_4C_3. The intermetallic compound Al_4C_3 as interlayer is beneficial to strengthen adhesion between CNTs reinforcement and the Al matrix. The uniformly distributed dispersions of CNTs, Al_2Cu, Al_2O_3 and Al_4C_3 can refine the crystalline structure, thus improving mechanical performance. Combined strengthening mechanisms are identified in the composites, containing grain boundary strengthening, dispersion strengthening and better load transfer from the Al-Cu matrix to CNTs though Al_4C_3.

Key words: CNTs; high temperature extrusion; microstructure evolution; Al-Cu alloy

1 Introduction

Carbon nanotubes (CNTs) are considered to be suitable candidates for metal matrix composites (MMCs) reinforcement due to high Young's modulus and tensile strength, nanometer size, and low density[1-4]. Aluminum alloy has been widely used in aviation, aerospace, automotive and chemical industries because of low density, good mechanical properties and corrosion resistance [5]. Wrought Al-Cu alloys are referred as AA2××× series aluminum alloys, which are characterized by high strength, low heat resistance and easy processing. The alloying system can be strengthened by precipitation hardening via heat treatment. Addition of CNTs in light alloy, such as aluminum alloys, has been widely used in aerospace, electronic packaging and transportation thanks to light weight, high aspect ratio strength and modulus and high thermal conductivity [6]. To date, much attention has been paid to carbon nanotube-reinforced Al matrix composite, especially on Al-Cu alloy [7-10].

However, CNTs are easy to aggregate because of strong van der waal's force among CNTs and the incompatibility between Al with CNTs. Therefore, investigating how to make the CNTs