A new design of composites for thermal management: Aluminium reinforced with continuous CVD diamond coated W spiral wires

Li Ma, Long Zhang, Pengyu Zhao, Naixiu Hu, Zhenzhi Gong, Wentao Ye, Quiping Wei, Kechao Zhou, Zhiming Yu, Yuefeng Zhang

PII: S0264-1275(16)30431-2
DOI: doi: 10.1016/j.matdes.2016.03.145
Reference: JMADE 1623

To appear in:

Received date: 18 December 2015
Revised date: 28 March 2016
Accepted date: 29 March 2016

Please cite this article as: Li Ma, Long Zhang, Pengyu Zhao, Naixiu Hu, Zhenzhi Gong, Wentao Ye, Quiping Wei, Kechao Zhou, Zhiming Yu, Yuefeng Zhang, A new design of composites for thermal management: Aluminium reinforced with continuous CVD diamond coated W spiral wires, (2016), doi: 10.1016/j.matdes.2016.03.145

A new design of composites for thermal management: Aluminium reinforced with continuous CVD diamond coated W spiral wires

Li Ma[a,1], Long Zhang[a,1], PengyuZhao[b], Naixiu Hu[b], ZhenzhiGong[b], WentaoYe[b], QuipingWei[a,b,*], KechaoZhou[a], ZhimingYu[b], YuefengZhang[b]

[a] State Key Laboratory of Powder Metallurgy, Central South University, Changsha 410083, PR China

[b] School of Materials Science and Engineering, Central South University, Changsha 410083, PR China

[1.]Co-first authors, these authors contributed equally to this work and should be considered co-first authors.

Corresponding authors at:

School of Materials Science and Engineering, Central South University, Changsha 410083, PR China. Tel.:+86 731 88830335; fax: +86 731 88876692. E-mail addresses: qiupwei@csu.edu.cn ([*]Q Wei), zhoukc2@csu.edu.cn (K Zhou).

Abstract

A novel design of Al matrix composite reinforced with diamond coated spiral tungsten wire is proposed for thermal management. Fabrication techniques of the diamond film reinforced Al matrix composites consist of hot filament assisted chemical vapour deposition (HFCVD) for diamond film, low-cost cold pressing and vacuum sintering of Al matrix composites. The microstructure characteristics and thermal properties of the composites have been studied. Results show that the diamond film retains its high quality and integrity after the vacuum sintering process. Even such a low content of diamond films in the filler- at most 6.5 vol.% - provides a thermal conductivity of 294 W/mK, about 69% higher than that of sintered Al and 79% higher than that of 6.5 vol.% diamond particles reinforced Al matrix composite fabricated by the same powder metallurgy process. Finite element analysis of heat transfer within such a structure is conducted, revealing that the continuous and thick diamond framework provides continuous channels and effective thermal conductive pathways for heat transfer. This work displays a great potential of CVD diamond films reinforced metal matrix composites for thermal conduction applications.

Keywords: Diamond film; CVD; Metal matrix composites; Diamond/Al; Thermal conductivity