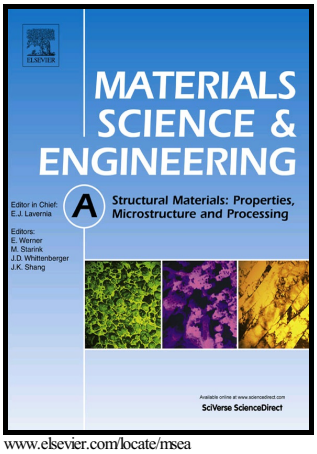
Deformation microstructures and strengthening mechanisms for the wire+arc additively manufactured Al-Mg4.5Mn alloy with inter-layer rolling

Jianglong Gu, Xiaoshu Wang, Jing Bai, Jialuo Ding, Stewart Williams, Yuchun Zhai, Liu Kun



www.elsevier.com/locate/msea

PII: S0921-5093(17)31574-5
DOI: http://dx.doi.org/10.1016/j.msea.2017.11.113
Reference: MSA35828

To appear in: *Materials Science & Engineering A*

Received date: 1 August 2017
Revised date: 25 November 2017
Accepted date: 27 November 2017

Cite this article as: Jianglong Gu, Xiaoshu Wang, Jing Bai, Jialuo Ding, Stewar Williams, Yuchun Zhai and Liu Kun, Deformation microstructures anc strengthening mechanisms for the wire+arc additively manufactured Al Mg4.5Mn alloy with inter-layer rolling, *Materials Science & Engineering A* http://dx.doi.org/10.1016/j.msea.2017.11.113

Deformation microstructures and strengthening mechanisms for the wire+arc additively manufactured Al-Mg4.5Mn alloy with inter-layer rolling

Jianglong Gu[a,*], Xiaoshu Wang[b], Jing Bai[b], Jialuo Ding[c], Stewart Williams[c], Yuchun Zhai[b], Liu Kun[d]

[a]State Key Laboratory of Metastable Materials Science and Technology, Yanshan University, Qinhuangdao 066004, P.R. China

[b]School of Materials Science and Engineering, Northeastern University, Shenyang 110819, P.R. China

[c]Welding Engineering and Laser Processing Centre, Cranfield University, Bedfordshire MK430AL,UK

[d]Department of Applied Science, University of Quebec at Chicoutimi, Chicoutimi G7H2W9, Canada

[*]Corresponding author, Email: gujianglong@ysu.edu.cn, Tel: +86 335 8074780, Fax: +86 335 8514884

Abstract

Applying inter-layer rolling to the wire+arc additively manufacturing (WAAM) process with increasing loads of 15 kN, 30 kN and 45 kN, achieves excellent mechanical properties for 5087 (Al-Mg4.5-Mn) alloys. Compared with the as-deposited alloy, the average micro hardness, yield stress and ultimate tensile strength of 45 kN rolled alloys reached to 107.2 HV, 240 MPa and 344 MPa, which were enhanced by 40%, 69% and 18.2%, respectively. Primary coarse grain structures were found to become greatly refined with an evident rolling texture after deformation. The strengthening mechanisms mainly are deformation strengthening, grain refinement, and solution strengthening. Meanwhile, the elongation of rolled alloys stays over 20%. The plasticity was not obviously diminished compared with the as-deposited alloy. This is two times greater than the commercial wrought Al-Mg alloy with similar composition. The excellent plasticity may be chiefly due to grain refinement, pores closure and reduction, and grain recrystallization during the WAAM re-heating process. The combination process of rolling deformation with WAAM deposition is an effective technique in refining microstructure and improving mechanical properties for AM aluminum alloys.

Key words: