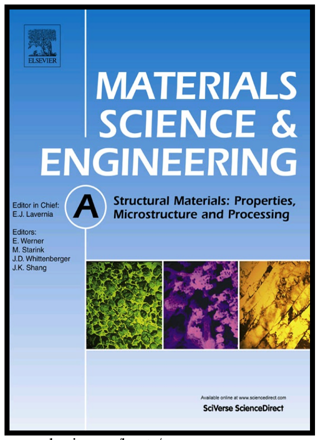

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PII: S0921-5093(18)30310-1
DOI: https://doi.org/10.1016/j.msea.2018.02.094
Reference: MSA36181

To appear in: *Materials Science & Engineering A*

Received date: 3 November 2017
Revised date: 20 February 2018
Accepted date: 26 February 2018

Cite this article as: Sara Bagherifard, Stefano Monti, Maria Vittoria Zuccoli, Martina Riccio, Ján Kondás and Mario Guagliano, Evaluating the potential of cold spray deposition for additive manufacturing of freeform structural components, *Materials Science & Engineering A,* https://doi.org/10.1016/j.msea.2018.02.094

Evaluating the potential of cold spray deposition for additive manufacturing of freeform structural components

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Abstract

Recent advances in the field of cold spray have put forward the potential of this deposition technique to be used as a non-thermal additive manufacturing process with significantly high deposition rates. In this study, we use the additive manufacturing potential of cold spray for fabrication of freestanding three-dimensional Inconel 718 samples, which is a challenging material for cold spray due to its high hardness and limited deformability. Additionally, we fabricated samples with similar geometry using one of the most common additive manufacturing methods, i.e. selective laser melting. Microstructural characteristics, distribution of residual stresses, porosity and structural integrity of the cold spray deposited samples were compared with those of samples obtained by selective laser melting before and after different heat treatments The results of the first time study of axial fatigue strength of cold spray deposited freeform samples indicate the notable efficiency of cold spray for fabrication of freestanding objects for structural components, with similar characteristics to those obtained from laser based additive manufacturing technique and even comparable to bulk material properties. The low working temperature of the cold spray method, suggests it as a promising additive manufacturing technique with a high potential to address many challenges regarding laser based approaches.

Keywords: Additive manufacturing, cold spray, selective laser melting, Inconel, fatigue strength

1. Introduction:

Cold spray (CS) is an emerging non-thermal deposition method with exciting applications coming along every day. In CS, bonding takes place when the velocity of the particles, that are accelerated by high pressure and pre-heated supersonic gas stream exceed a critical velocity [1]. The intrinsic features of CS are the possibility of depositing metallic powders at solid state at working temperatures much lower than the melting point of any of the involved materials [2, 3]. Thus, the main basis of bonding in CS is kinetic energy, contrary to other thermal spray coating techniques that are basically relying on thermal energy to induce metallurgical bonding. Thus far, CS has been mostly used as a mass production coating technique for thick coating deposition, corrosion protection or dimensional restoration and repair [3, 4]. However, the possibility of obtaining highly dense deposits with no theoretical limit to the thickness brings on the most recent application in the horizon for CS that is additive manufacturing (AM). CS process can offer numerous advantages in the field of AM compared to other common powder bed layer by layer fabrication techniques including selective laser melting/sintering (SLM/SLS), direct metal deposition (DMD) and electron beam melting (EBM). Such advantages can be listed as:

i) the opportunity to be used for deposition of temperature/oxygen sensitive material since no extra heat comes into play contrary to laser based AM techniques [5];
ii) induction of minimal or compressive residual stresses contrary to tensile residual stresses typically induced in laser based AM techniques;