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Author: Richard J. Smith Matthias Hirsch Rikesh Patel Wenqi Li Adam T. Clare Steve D. Sharples

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Spatially Resolved Acoustic Spectroscopy for Selective Laser Melting

Richard J. Smith[a], Matthias Hirsch[b], Rikesh Patel[a], Wenqi Li[a], Adam T. Clare[b*], Steve D. Sharples[a]

[a]*Advanced Optics Group, Faculty of Engineering, The University of Nottingham, Nottingham, United Kingdom, NG7 2RD, U.K.*

[b]*Advanced Manufacturing Group, Faculty of Engineering, The University of Nottingham, Nottingham, NG7 2RD, U.K.*

Graphical abstract

Abstract

Additive manufacturing (AM) is a manufacturing technique that typically builds parts layer by layer, for example, in the case of selective laser melted (SLM) material by fusing layers of metal powder. This allows the construction of complex geometry parts, which, in some cases cannot be made by traditional manufacturing routes. Complex parts can be difficult to inspect for material conformity and defects which is limiting widespread adoption especially in high performance arenas. Spatially resolved acoustic spectroscopy (SRAS) is a technique for material characterisation based on robustly measuring the surface acoustic wave velocity. Here the SRAS technique is applied to prepared additively manufactured material to measure the material properties and identify defects. Results are presented tracking the increase in the measured velocity with the build power of the selective laser melting machine. Surface and subsurface defect measurements (to a depth of ~24 μm) are compared to electron microscopy and x-ray computed tomography. It has been found that pore size remains the same for 140W to 190W melting power (mean: 115-119 μm optical and 134-137 μm velocity) but the number of pores increase significantly (70-126 optical, 95-182 velocity) with lower melting power, reducing overall material density.

Keywords: Non-destructive Testing, Spatially Resolved Acoustic Spectroscopy, Selective Laser Melting, Additive Manufacture, Titanium Ti-6Al-4V

Introduction

Additive manufacturing is a rapidly growing area for complex part manufacture and encompasses a wide variety of different techniques, all of which have the property of additive accumulation of material to form the part. Some of the techniques build parts layer by layer which offers the possibility of integration of the build process with existing inspection techniques. Selective laser melting (SLM) is an additive manufacturing (AM) technique that can produce complex geometrical, ‘high value’ parts for the aerospace (Abe et al., 2001), tooling (Voet et al., 2005) and medical industry