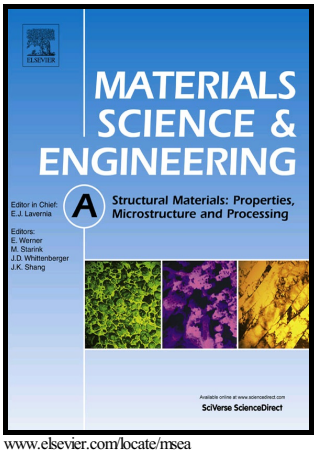
Comparison of microstructure and mechanical properties of 316L austenitic steel processed by selective laser melting with hot-isostatic pressed and cast material

Karina Geenen, Arne Röttger, Matthias Windmann, Florian Binner, Werner Theisen



www.elsevier.com/locate/msea

PII: S0921-5093(16)31220-5
DOI: http://dx.doi.org/10.1016/j.msea.2016.10.012
Reference: MSA34214

To appear in: *Materials Science & Engineering A*

Received date: 28 April 2016
Accepted date: 4 October 2016

Cite this article as: Karina Geenen, Arne Röttger, Matthias Windmann, Florian Binner and Werner Theisen, Comparison of microstructure and mechanical properties of 316L austenitic steel processed by selective laser melting with hot isostatic pressed and cast material, *Materials Science & Engineering A* http://dx.doi.org/10.1016/j.msea.2016.10.012

Comparison of microstructure and mechanical properties of 316L austenitic steel processed by selective laser melting with hot-isostatic pressed and cast material

Karina Geenen*, Arne Röttger*, Matthias Windmann, Florian Binner, Werner Theisen
Chair of Materials Technology, Institute for Materials, Ruhr-Universität Bochum, Germany
geenen@wtech.rub.de
roettger@wtech.rub.de
*Corresponding authors:

Abstract

Besides the chemical composition, the manufacturing route primarily determines a material's properties. In this work, the influence of the manufacturing process of the 316L grade austenitic steel on the microstructure and the resulting material properties were investigated. Thus, the microstructure and mechanical properties of cast and solution annealed, as well as steel powder densified by hot-isostatic pressing (HIP), selective laser melting (SLM) and SLM+HIP, were compared. A SLM parameter study illustrates that the porosity of SLM-densified specimens can be reduced with direction of a higher exposure time and a smaller point distance. With an additional treatment by HIP, the porosity scarcely changes, while cracks are reduced. The mechanical properties were investigated depending on the manufacturing process, and the influence of the sample build up by SLM was examined. High mechanical values have been obtained; in particular, the yield strength in the SLM-densified condition is much higher than in cast or HIP condition, as a result of the smaller grain size.

Keywords

additive manufacturing; selective laser melting; hot-isostatic pressing; austenitic steel; mechanical properties

1. Introduction

In the future, additive manufacturing will gain a key role for the production of component parts. With regard to a constructional point of view, complexly-formed, three-dimensional component parts can be designed using CAD techniques, and directly produced within a short time and with less effort, thus leading to a reduction in development and production time and cost savings. In this context, keywords like rapid prototyping, rapid manufacturing and rapid tooling can be mentioned. Besides this economical aspect, an ecological handling of materials becomes more important, due to the growing need for goods in light of the growing world population and increasing globalization [1–3]. On this account, saving resources like material and energy is of great importance; thus, the demand for technical products can be satisfied in the future as well. These additive manufacturing techniques enable the production of near net shaped and complexly formed component parts based on CAD structures - with minimal material usage - thus meeting the aforementioned ecological and economic necessities [1,3,4]. Various additive manufacturing techniques have therefore been developed within the last three decades. For the processing of dense metallic components, electron beam melting (EBM) and selective laser melting (SLM) are of high interest. Besides the use of different heating sources, both techniques are characterized by nearly the same process sequence. In