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► To cite this version:

Jitendra-Singh Rathore, Florian Le Bourdais, C. Ly, M. Pellat, A. King, et al.. Comparison of porosity evaluation techniques for L-PBF manufacturing. ICWAM 2022 - Third edition of the International Congress on Welding, Additive Manufacturing and associated non destructive testing, Jun 2022, En ligne, France. cea-04418214

HAL Id: cea-04418214

<https://cea.hal.science/cea-04418214>

Submitted on 25 Jan 2024

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Comparison of porosity evaluation techniques for L-PBF manufacturing

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Abstract

Porosity is a major concern in additively manufactured (AM) parts; therefore, its accurate detection and measurement becomes extremely crucial for ensuring the safety of the part. In this work, we have manufactured several AM samples of AlSi7Mg in the form of small cylinders (10 mm diameter) by modifying each time few relevant fabrication parameters.

The Archimedes method is traditionally used as a classical and low cost technique for density (or porosity) determination. Although fast in terms of time and data processing steps, its accuracy is somewhat limited and it gives only a global information. Especially, it does not provide information about the distribution and sizes of the pores.

X-ray computed tomography, on another hand, is a powerful but expensive tool for holistic measurements of pores. We have analysed the AM samples first with laboratory micro-tomography and we have compared the results to those of the Archimedes method. In addition, an ultra-high resolution (2.3 μm) tomography has been obtained from synchrotron CT to cross-check the effect of resolution on porosity determination when compared with laboratory X-ray CT.

On a different line of investigation, the Resonant Ultrasound Spectroscopy (RUS) technique is also suitable for fast porosity evaluation, since the density reduction modifies the resonance spectra. In this work, the focus is on the validation of the information obtained from all the techniques in order to assess the practical limitations of each of the techniques for density evaluation.

Keywords

Additive manufacturing; porosity; Archimedes method; X-ray tomography; synchrotron CT, RUS