Prediction and optimization of materials properties in Additive Manufacturing

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Dynamics Based Maintenance

Introduction

Additive Manufacturing (AM) is the given name for any process that consists of layer-by-layer material deposition. Nowadays several kind of materials can be processed by this group of techniques. More specifically metal-based-machines (Figure 1) are being developed and optimized to fulfil a high demand in several industry sectors (aerospace, defense, maritime, biomedical)

(a) (b)

Figure 1: Directed energy deposition [1] (a), Powder bed fusion [2] (b)

Challenge

The main challenges in building parts with AM technologies are:

- Layer-by-layer means anisotropy
- Powder metallurgy provides porosity
- The process generates local thermal stresses

Research objective

Studying by experimental work the interaction between materials properties and process conditions (Figure 2)
Understanding and modelling the correlation between the different AM process steps with final performance

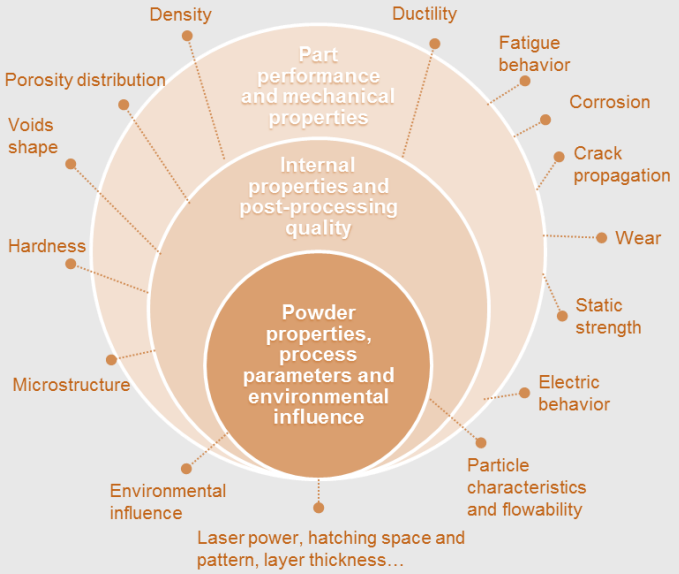

Figure 2: Steps in AM methodology research

Results

Figure 3 shows the water decrease of a metal powder (AlSi10Mg), revealing that it is necessary to pay special attention to the storage conditions to avoid all kind of material contamination (especially moisture):

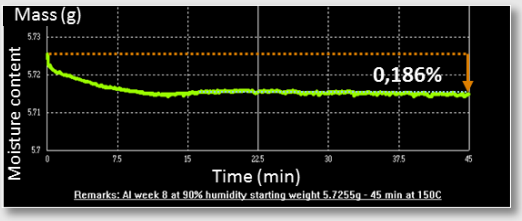

Figure 3: Moisture loss analysis of metal powder

SLM process parameters and final properties are closely related. See Figure 4: microstructure and melting pool size of Inconel 718 depend on the layer thickness variation (30 and 50 µm):

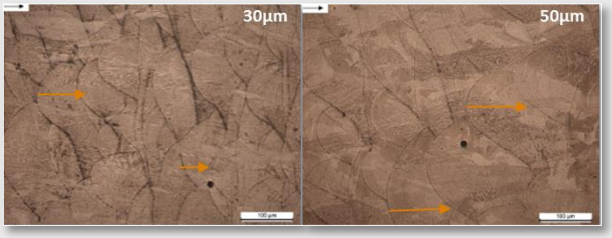

Figure 4: Microstructure of Inconel 718

Future work

- (On-going) Analyse the process (and post-activities) to find “best practices” for materials properties optimization. Study the sensitivity of internal properties to external conditions fluctuation and its correlation with the part performance (see also Figure 2)
- Design a decision tool that helps to accelerate the process of switching to AM process by predicting the new materials properties and technology benefits
- Gather and summarize “guidelines“ for future AM users and interested parties

Application

The frame of this research is SINTAS (Sustainability Impact of the New Technologies Afters sales Supply chain) [3]. Therefore the aim of the investigation is to identify the possibilities of applying AM to spare parts of different industries and quantify the impact of this change: both technological and from the logistics point of view.

References

[1] http://www.trumpf-laser.com/
[2] https://3dprint.com
[3] http://www.dinalog.nl/en/project/sustainability-impact-of-new-technology-on-after-sales-service-supply-chains-sintas/

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PhD progress

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