OPTIMIZATION OF ADDITIVE MANUFACTURING PARAMETERS FOR IMPROVING PART QUALITY AND PROCESS SUSTAINABILITY

Ersilia Cozzolino – Advisors: Prof.ssa Valentina Lopresto, Prof. Antonello Astarita

Curriculum: Tecnologie e Sistemi di Produzione

Sustainable Manufacturing is gaining increasing attention in the research community and has moved beyond it to gain wide acceptance in business and in industry. It is the creation of manufactured products through economically-sound processes that minimize negative environmental impacts while conserving energy and natural resources. Thanks to digital transformation, Industry 4.0 create great opportunities for sustainable manufacturing which also enhances employee, community and product safety.

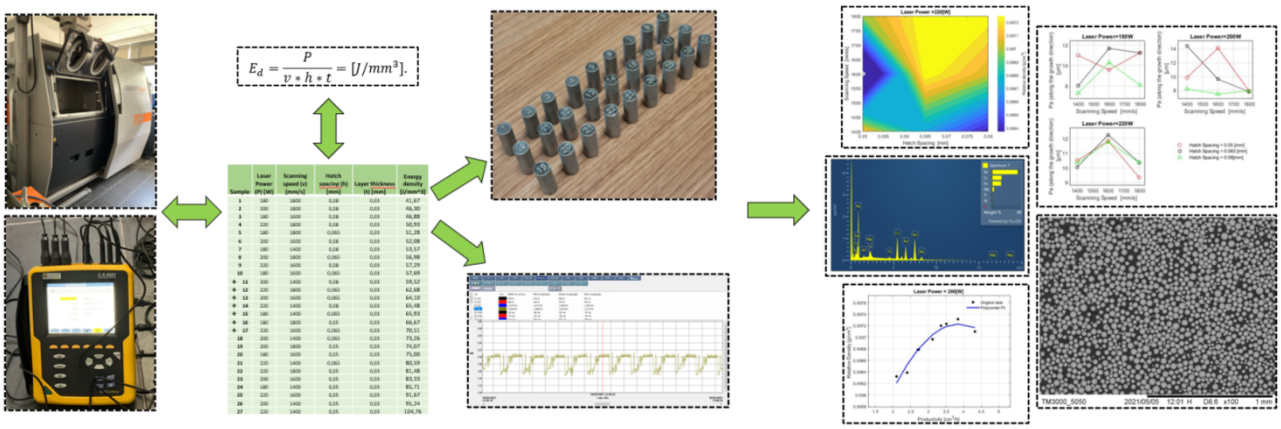
Additive Manufacturing (AM) is configured as one of the vital components of Industry 4.0 because it satisfies the necessity of mass customization. AM is defined as a manufacturing process which is used to produce three-dimensional objects by adding layers of material based on a three-dimensional computer model. Thus, AM is becoming a key technology for fabricating customized products due to its ability to create sophisticated objects with advanced attributes. Thanks to increased product quality, AM is currently being used in various industries such as aerospace, biomedical, and manufacturing. Being a developing technology to create accurate and strengthened intricate objects with increased production speed, it may offer a way of replacing the conventional manufacturing techniques in the near future.

Claimed as a green technology, AM holds great potential in improving materials efficiency, reducing life cycle impacts, and enabling greater engineering functionality compared to conventional methods, including less requirement for special tooling in part fabrication, rapid tooling production, and reduced material waste. Consequently, time and cost can be potentially reduced for individualized and small-volume parts manufacturing. Bearing in mind that energy consumption in AM could not only affects the sustainability of the process itself but also influences the microstructure and mechanical properties of the fabricated components, scientific literature lacks of guidelines to obtain products made by Additive Manufacturing with good mechanical properties by saving energy and reducing the impact on the environment.

Ersilia Cozzolino's doctoral research project focuses on the study of sustainability of Additive Manufacturing processes. Her research aims to understand how to produce products through Additive Manufacturing technologies that meet, on the one hand, quality requirements for industrial applications, and, on the other, environmental ones. In particular, the research purpose is to understand how to vary the parameters of additive processes in order to obtain products with good mechanical properties with a low impact on the environment and what could be useful indicators to evaluate the sustainability of processes.
It is known in the scientific literature as well as in industrial production that products fabricated by Additive Manufacturing processes can't be used as-built but require post-processing phases by using traditional technologies, whose processes have an impact on the environment as well. Therefore, the research activity not only looks at the sustainability of the Additive Manufacturing processes but the entire production cycle to obtain the product, and therefore also the post-processing phases that are necessary to obtain a surface finish of acceptable products. During the experimental activities, therefore, the energy consumption and consumption of resources will be monitored in order to obtain useful results that hopefully help industrial companies to rethink the processes in a sustainability perspective. The final objective will be, on the one hand,

to fill the gaps of knowledge present on the subject in the scientific literature, and thus contribute to the dissemination of new knowledge, and on the other hand, provide guidelines to the industrial world, where sustainable production will become imperative in the coming decades.

The first year of the PhD is firstly focused on the study of existing scientific literature about the Additive Manufacturing Processes, with a particular regard on Selective Laser Melting and Fused Deposition Modeling. Moreover, it is paid attention to which are the main indicators measuring the sustainability of AM processes and how implement them experimentally. Secondly, it will be manufactured samples in Inconel 718, a high performance alloy mostly used in aerospace sector, throughout Selective Laser Melting process by varying process parameters, such as laser power, scanning speed and hatch spacing, and simultaneously by measuring energy consumption. Due to the fact that sometimes the surface finishing of 3D printing is not adequate so that machining is required, the assessment of the sustainability should consider both the steps. Then, on the one hand it will be assessed the sustainability of the production of IN718 parts by means of SLM and post building machining and on the other hand an analysis of the mechanical properties and behavior of the samples will be done. The results will give some guidelines about the optimal process parameters to choose for improving part quality and process sustainability.



Ersilia Cozzolino, PhD student XXXVI cycle, May 2021