Chapter 9
Optimization of Additive Manufacturing for Layer Sticking and Dimensional Accuracy

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ABSTRACT

When the 3D printing process is considered, there are also other parameters, such as nozzle size, flow rate of material, print-speed, print-bed temperature, cooling rate, and pattern of printing. There are also dependencies that will be addressed in between these parameters; for example, if the printing temperature is increased, it is not clear if the viscosity of the material will increase or decrease. This chapter aims to explain the effect of printing temperature on layer sticking while dimensional accuracy is achieved. Theoretical modelling and experimental testing will be performed to prove the relationship. This type of formulation can be later adapted into a slicer program, so that the program automatically selects some of the printing parameters to achieve desired dimensional accuracy and layer sticking.

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INTRODUCTION

Additive manufacturing is gaining importance in mechanical design processes since it allows an easy way of prototyping. However, even though 3D printers are becoming more common and easy to use, the relationship in between the printing parameters and the part properties is not clearly known.

In this chapter, the strength of the part is defined as the sticking of the layers to each other. The effect of the printing parameters, namely print speed, print temperature, fan speed and layer height, to the layer sticking is experimentally tested.

3D printing technology has been defined as to have transformative implications (Jong & Bruijn, 2013). In the current literature there are several works on this topic. Some of the hot studies are fabrication procedures in rapid prototyping (Suresh & Narayana, 2017), surface characterization (Boschetto, 2017), laser additive manufacturing (Mahamood & Akinlabi, 2017), laser metal deposition process (Mahamood, 2017) and production of fully functional 3-D printed components (Kocovic, 2017). There are studies on ABS material and in these studies the results of injection molded parts with FDM printed parts were compared. The injection molding showed higher resistance to the impact, hardness, and tensile fractures than the 3D printed parts did. Moreover, their study also includes the 3D printed parts printed at different layer heights. It is also experimentally concluded that the decrease in layer height resulted in parts with higher strength (Pritish et al., 2016). Moreover, the build parameters of low print speed and small layer height resulted in the most resistance to flexural and tensile fractures (Christiyan et al., 2016). This is explained by better layer sticking under low print speed and small layer height. The increase of nozzle head temperature resulted in higher tensile fracture resistance (Behzadnasab & Yousefi, 2016). It is also proved that increasing the layer thickness decreases the tensile strength (Vaezi & Chua, 2011).

The effect of build orientation, layer thickness and feed rate on mechanical properties has been studied in (Chacon et al., 20170 and proven that build orientation also plays a vital role on the mechanical properties of a 3D printed part.

The effect of cooling air speed is studied in (Lee and Liu, 2019) and the dimensional accuracy and the strength of the part is measured. It has been seen that increasing the cooling air speed decreases the dimensional accuracy but improves the part strength.
Surface Roughness Estimation of Turned Parts from Optical Image Measurements and Wavelet Decomposition

Investigation of the Effect of Cutting Conditions and Tool Edge Radius on Micromachining with the Use of the Finite Elements Method