

Research Proposal for Bachelor Thesis

Effects of different 3D Printer Nozzles Material on 3D printing Polylactic Acid (PLA) and its Abrasive derivatives

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Introduction

3D Printing is the process of creating a 3D model or object into reality, it was first developed in 1981 by Japanese Researcher Hideo Kodama with a layer-by-layer technique. Which was later most popularly known as Fused Deposited Modeling (FDM). It is a part of a wider technique known as the Additive Manufacturing Method because it involves of adding/fusing material to create the product.

Nowadays, many and many more 3D printers have entered the market and the price of the 3D printer has become more affordable to purchase even for home consumer grade. This also came along with the fact of more and more materials are being developed to meet the requirement of 3D printing by many types of customers.

The material used for 3D printing by Fused Deposition Modeling is called a Filament. A filament is a thermoplastic that must follow a Heating, Extruding, and Cooling Process during a printing cycle. The process began with the Filament being Heated to just slightly above its glass transition temperature inside a chamber that is more known as a Hotend. Then it is extruded by the Hotend to a flat surface where it will be cooled down. The process is continuing layer by layer to make a finished model.

There are several types of Filaments available in the market. The most used for 3D printing are Polylactic Acid (PLA), Acrylonitrile Butadiene Styrene (ABS), and Polyethylene Terephthalate Glycol (PETG). Some Unique and Exotic types of filaments are available for 3D printing, although they might require some special modification to the machines or the printing environment to get the most optimized results from them.

One of the types of Exotic/Unique Material is the Abrasive type of filaments. These kinds of Filaments can cause accelerated wear damage for the stock brass-made nozzle for 3D printers. To print them effectively without making much damage to the printer itself, some modifications are required to effectively use the abrasive type of filaments. For example, Wood Filaments which is a blend of basic PLA and some wood fibre to make its unique Wood-like feel.

Some Popular Nozzle Materials to use for 3D printing:

- Brass Nozzle
- Stainless Steel Nozzle
- Hardened Steel Nozzle
- Copper Plated Nozzle
- Ruby Tipped Nozzle

Literature Review

The 3D printing process or more known as Additive Manufacturing is a process in which adding a melted plastic called filament layer-by-layer to create a pre-defined 3D model and sent into software that will “slice” the model into layer-by-layer and made a series of commands that any additive manufacturing machines could understand which is the Gcode. Some of the most common software are Ultimaker Cura, Prusa Slicer, SuperSlicer, and much more software to achieve better quality results.

The Additive Manufacturing process offers an efficient technique of creating a model part at the lowest cost possible and required no further post-processing/tooling/manufacturing required. And also has been proven to be able to create complex geometrical parts safely and it's safe to use at home and in office environments.

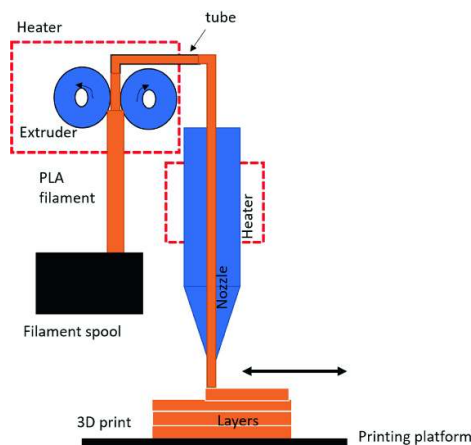


Fig 1. The Principle of Fused Deposition Modelling

Although all the Processes of Additive Manufacturing can be pretty interesting to study and use for daily purposes, it also comes with their disadvantages such as limited working space, a lower resolution when it comes to printing smaller details, and sometimes could be prone to breaking when there is a force applied parallel to their layers.

And there are some specific times when it comes to the need to have to change the standard brass nozzles which are commonly found on most 3D printers nowadays. Usually printing an exotic printing material could potentially damaging the standard brass nozzle. They're called the abrasives material.

Abrasive Materials can come in many ranges of quality, purposes, and most importantly price ranges. However, the most common that can be found in the market are usually the derivatives of Polylactic Acid (PLA) that have been through the addition of extra additives to make their unique properties and look after the whole process of additive manufacturing. Sometimes the added additives that making a change in 3D printing nozzles to maintain the quality, accuracy, and longer nozzle usage life.

The objective of The Thesis

- Evaluating and choosing the best out of all options in the market regarding which types of 3D printer Nozzles for daily and specific purposes

Empirical Method and Structure of the Thesis

The first part of the Thesis should have introduced to the reader the existing 3D printing technology, especially the FDM method. The Particular interest of this part would be the background of FDM 3D Printing and the personal experience using a 3D printer for a while.

The Main part of the thesis should have covered how different types of 3D Printing Nozzle Material could have affected the whole process of 3D printing of Polylactic Acid (PLA) and its derivative. One of the reasons people want to use a different type of nozzle for their 3D prints rather than a standard brass nozzle offered by the manufacturer. Some nozzles were made with different materials with their purpose. There should be a difference in terms of print settings and temperature because different nozzle materials have different heat transfer coefficients and thermal conductivity.

The final part of the Thesis should be covering integrating this thesis into more commonly known research regarding the nozzle material types as well as the relevance of the findings during the Thesis. Also includes what needs to be clarified in future research and if this research is only natural or can be applied to a real-world application.

Research Methodology

- Using a Thermocouple Type K to measure the actual temperature in the nozzle compared with the temperature that the 3D Printer shows on the screen
(Note: Thermocouple Type K is used because it can withstand heat up to 1260°C with an accuracy of $\pm 0.75\%$ or $\pm 2.2^\circ\text{C}$ and with a sensitivity around $41\mu\text{V}/^\circ\text{C}$)
- The object that is going to be 3D Printed is a 3D printer benchy boat. Which is a common standard benchmark for a 3D printer that can show any error regarding the dimensional accuracy, print settings, tolerances, and deviations regarding changing the nozzle types
- Drying all the test filaments before the whole process could begin to ensure dryness during print to achieve the best optimal results

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