Cooling a 3D Print

Mechanical Engineering

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Abstract

Filament extruding printers have issues with printing overhangs, which become stringy and lose their designed shape. To combat this, printers use supports that increase cost and print time as well as add an extra step in cleaning the printed product. Another solution is rapidly cooling the filament to help a print keep its shape and avoid any unwanted stringiness. We will be testing how well cooling can improve overhangs, affects spatial resolution and material properties. With rapid cooling, we should be able to make two parts very near each other without them fusing.

We will begin by printing a control model to see at what angle the model becomes stringy. Then we will print a set of ducts to have a relatively even flow all around the nozzle. We will have a microblower attached at the other end of the vent. By varying the voltage input to the fan we can control fan speed. This, along with an IR thermometer to measure the output temperature, will give us our variables. We are also interested in how cooling affects the material properties of the printed filament. To do this, we will be printing several dogbones, cooled and uncooled, of various layer orientations and running tensile tests on them.

Design

- Variable Speed DC Fan
- Duct directs airflow evenly around extruded filament
- Cools the filament, solidifying it before it can droop

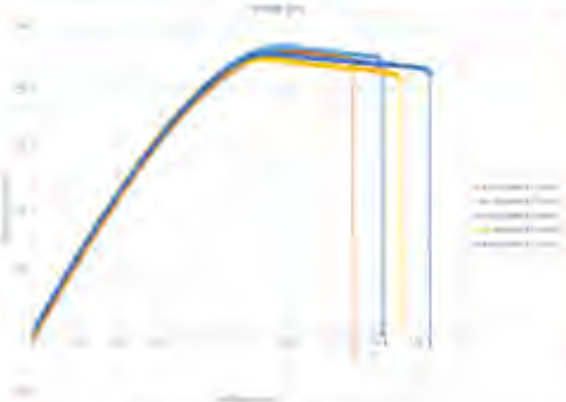
Printed product model used to cool our filament

Testing - Strength

- ASTM Type 1 dogbone for plastic
- One set cooled using our device
- Control set printed uncooled
- Both sets printed in controlled environments
- Both sets printed withPLA filament
- Square 20% infill was used
- Layer thickness 0.2mm

Dogbone on ASTM Tensile Tester

Results - Strength



Control	
Avg. Max Load	Avg. Max Elongation
-456.6099657	0.168402049

- Control
  - Load required to fail was within 5% error
  - Elongation at failure was within 10% error
  - Specimens failed with little elongation
  - Ultimate Tensile Strength: 3.3 x 10^3 psi

Overhang Problems

Failed Horizontal Overhangs

- Used a model designed to test overhang
- A cooled and a control specimen printed

Results - Overhang

Specimen without/with induced cooling

Analysis/Conclusion

Proper cooling of a 3D printer filament yields an overall higher quality finish of the final printed part. The part also require less support when printing, leading to a faster print time and less material required. Cooling can be used to make complex parts with overhangs and reduces the amount of time spent cleaning the part.

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