Vertical Bunsen Burner Testing of 3-D Printed Material

Presented to: International Aircraft Materials Fire Test Forum
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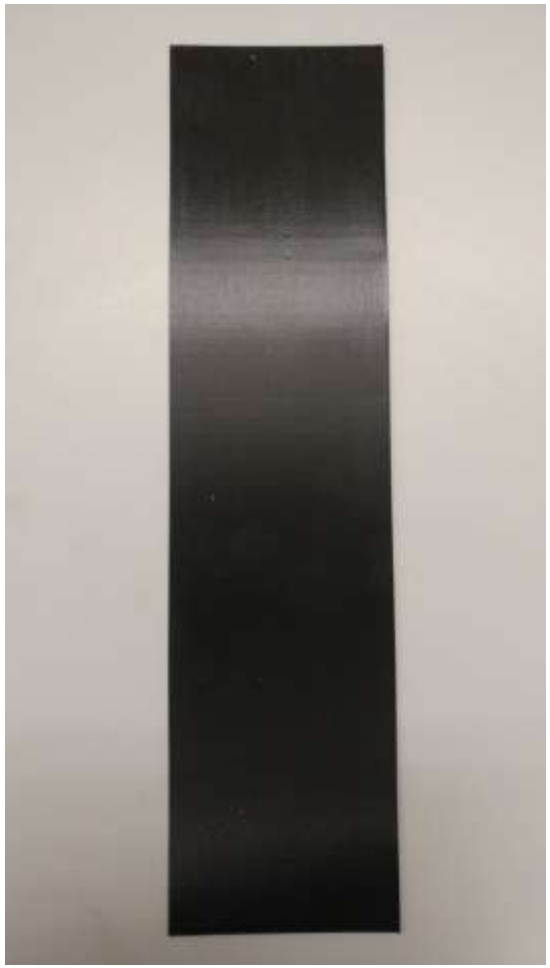
Introduction

- **Test solid 3-D printed material in Vertical Bunsen Burner**
- **Nylon-12 material**
- **12” × 3” × 0.060” Samples**
- **12” × 3” × 0.10” Samples**
- **Printed in 3 orientations**
  - Flat (XY), Sideways (YZ), and Standing (ZX)

Nylon-12 – 0.060 inch

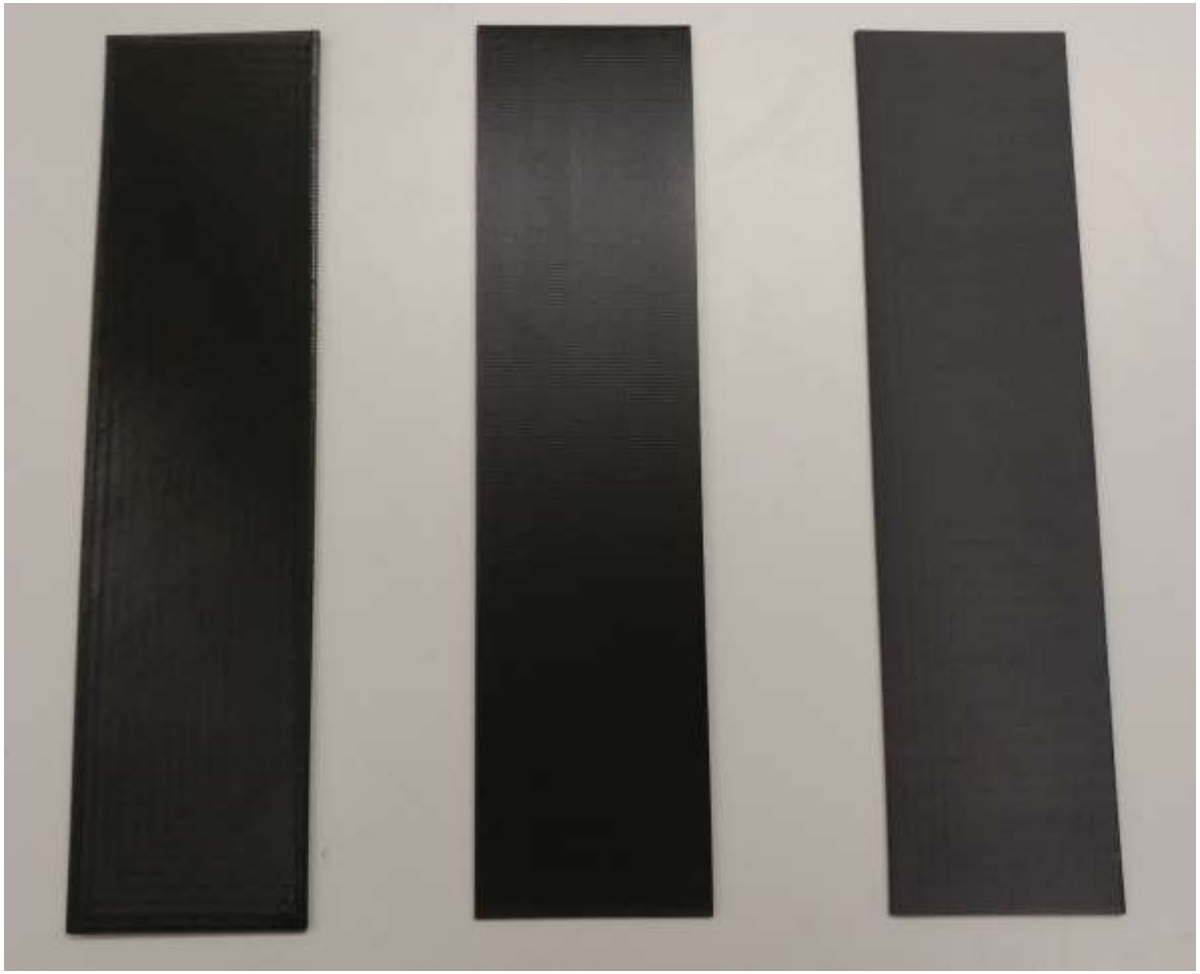
XY-Direction



YZ-Direction

ZX Direction

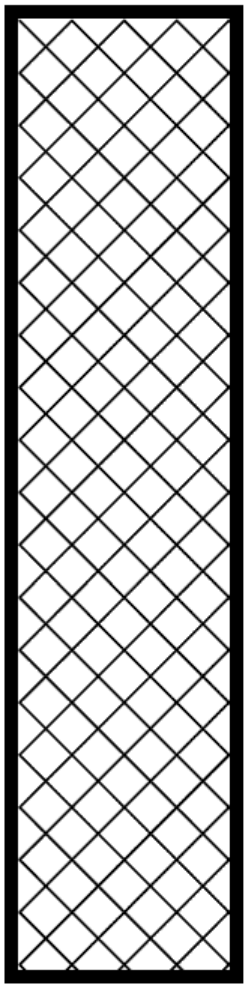
Nylon-12 – 0.10 inch



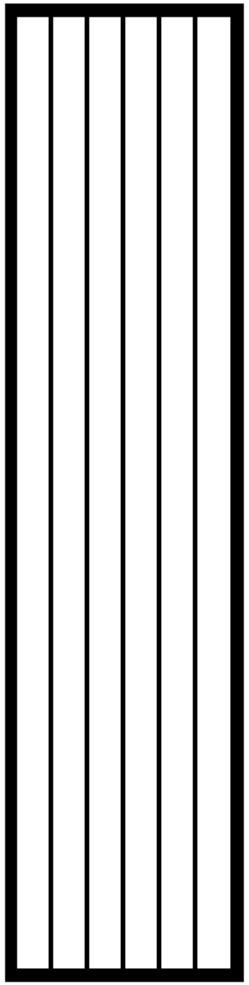
XY-Direction YZ-Direction ZX Direction

Printing Orientations

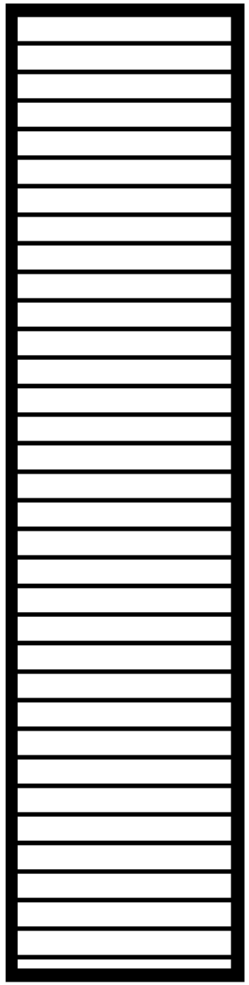
- 3 orientations
- 2 thicknesses
  - 0.060” (~1.5 mm)
  - 0.10” (~2.5 mm)
- 0.10” slice height
- 0.20” printing width



XY-Direction



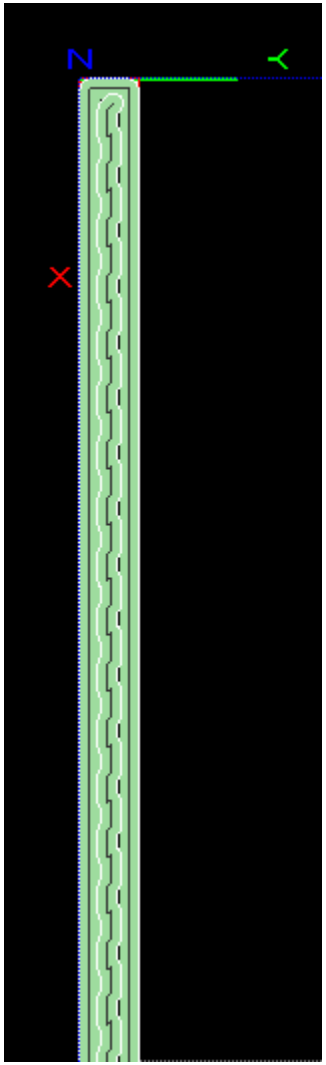
YZ-Direction



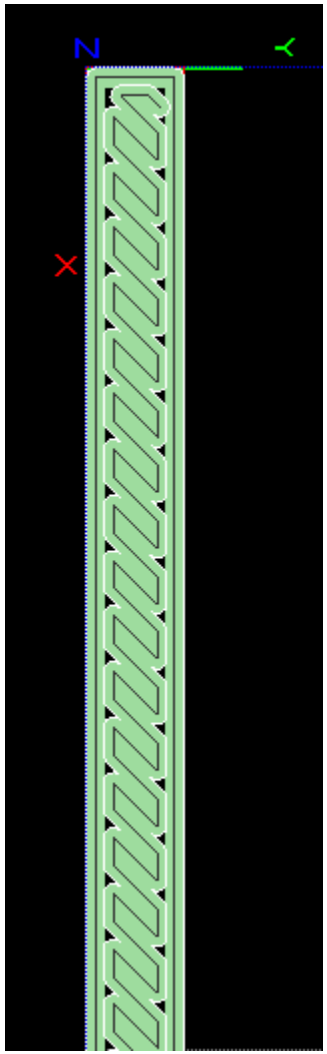
ZX Direction

Nylon-12

- Toolpath of 3-D printer printing at different thicknesses
- Printing in XY-direction produces an identical cross-section no matter the thickness
- YZ and ZX direction have more cross-hatching inside with thicker samples



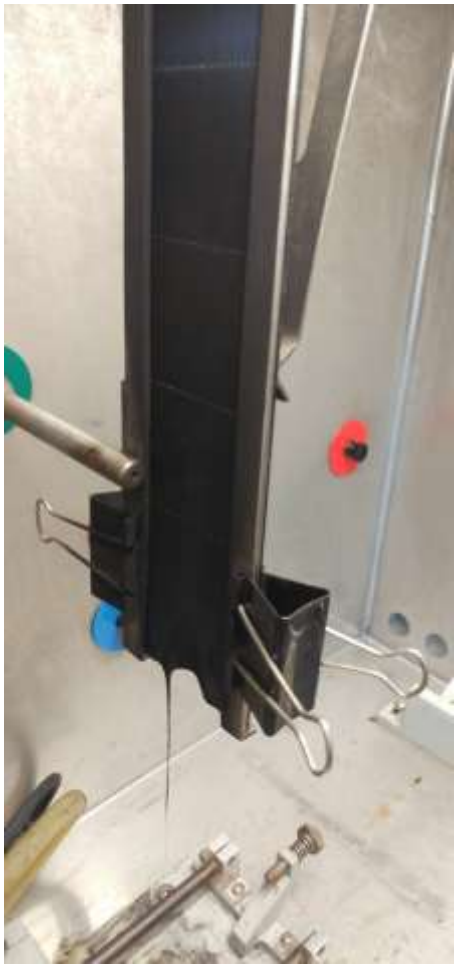
0.060 inch



0.10 inch

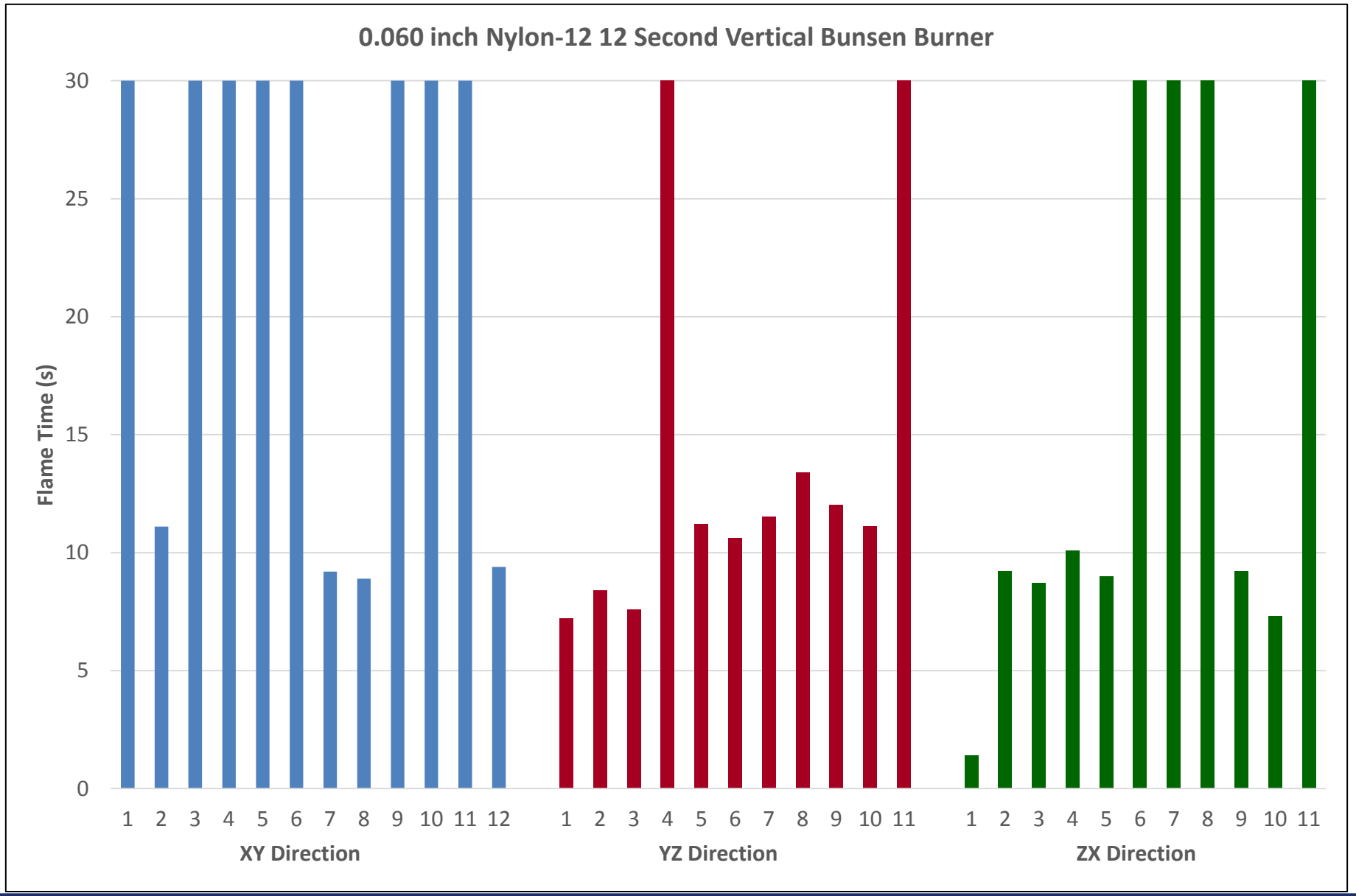
Nylon-12

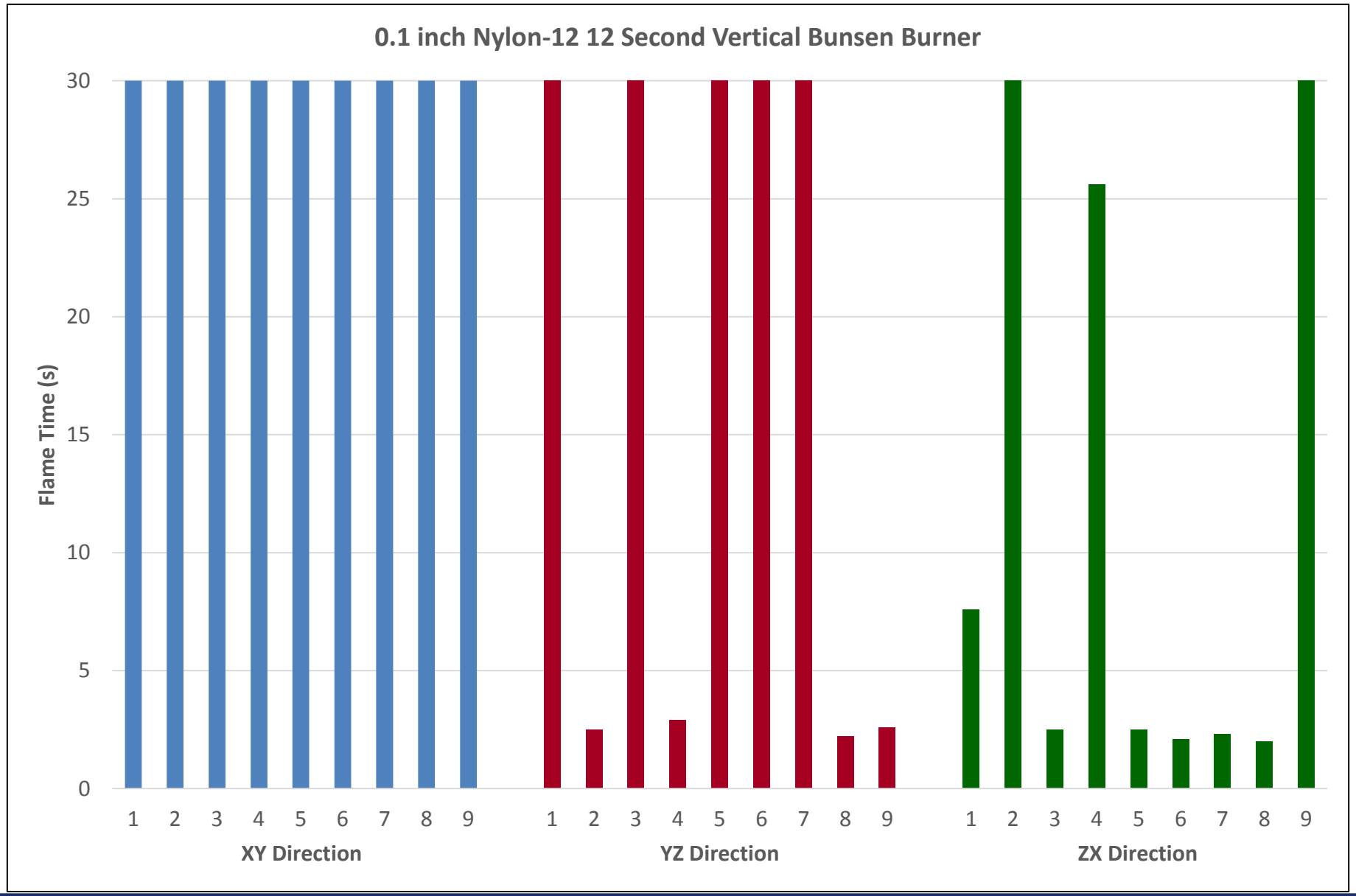
- Drip flame time was difficult to measure because there were several drips that fell on top of each other
- Flames extinguished because of dripping
- Burn length wasn't accurate because of the large amount of samples that had to be manually extinguished.

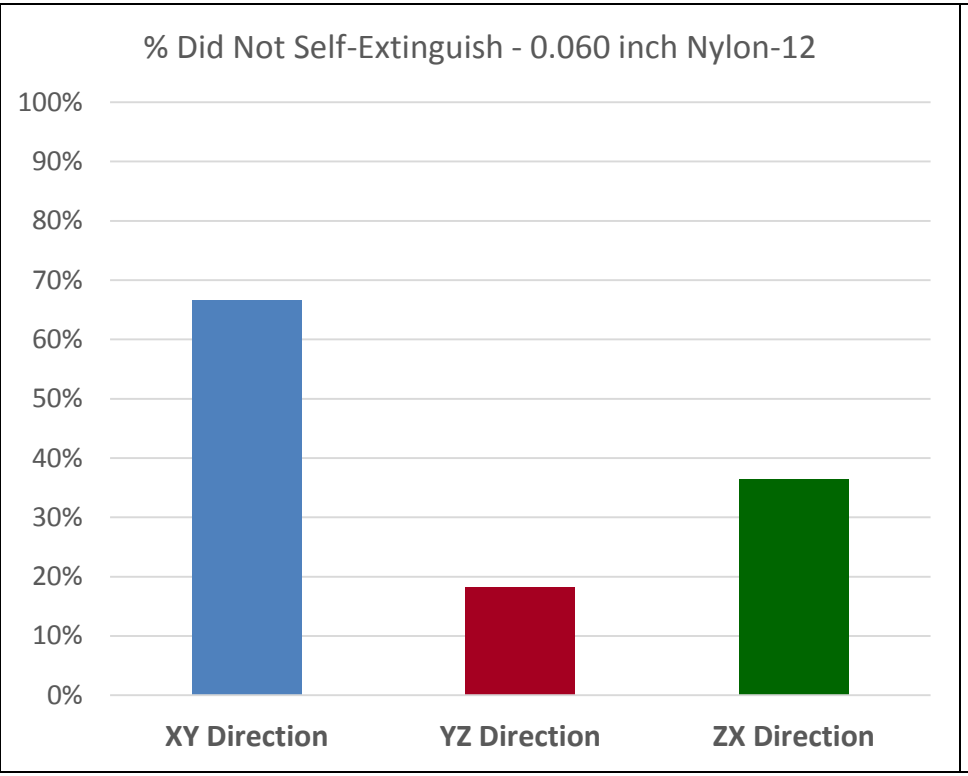


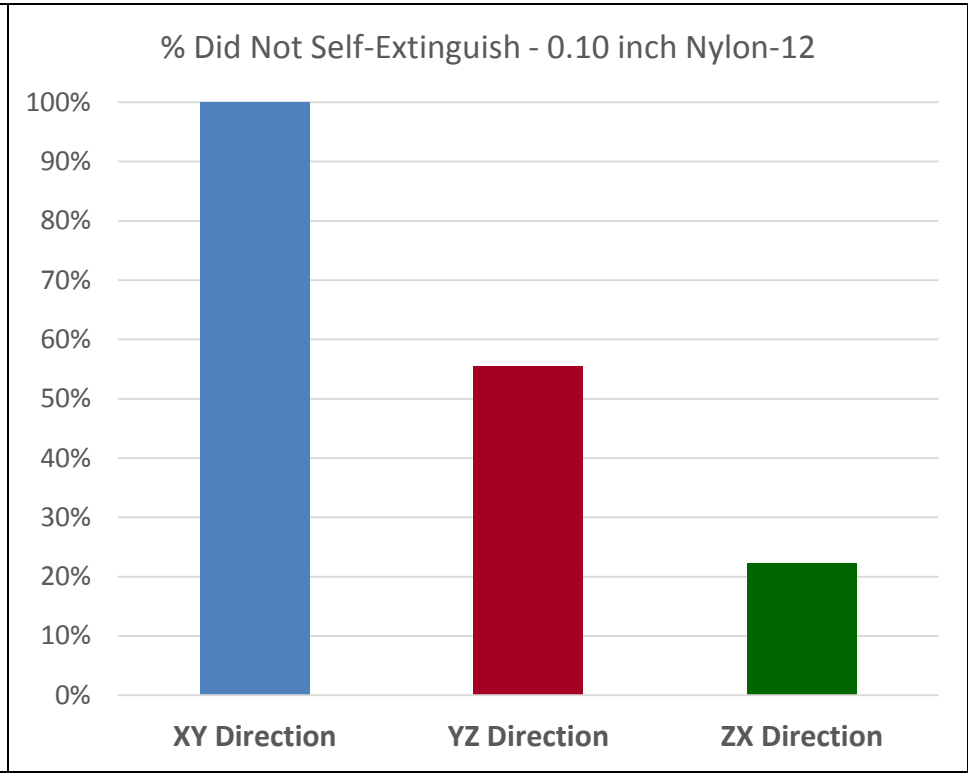
YZ-Direction

ZX Direction


0.060 inch Nylon-12 12 Second Vertical Bunsen Burner
Flame Time (s)
0
5
10
15
20
25
30
1 2 3 4 5 6 7 8 9 10 11 12
XY Direction
1 2 3 4 5 6 7 8 9 10 11
YZ Direction
1 2 3 4 5 6 7 8 9 10 11
ZX Direction


0.1 inch Nylon-12 12 Second Vertical Bunsen Burner
Flame Time (s)
0
5
10
15
20
25
30
1 2 3 4 5 6 7 8 9
XY Direction
1 2 3 4 5 6 7 8 9
YZ Direction
1 2 3 4 5 6 7 8 9
ZX Direction





- XY-direction did not self-extinguish the most for both thicknesses
- Cross-hatching pattern doesn't drip as easily leaving the sample in place to burn

Conclusion and Future Work

- **Nylon-12 showed some difference in printing orientation**
  - XY-direction was most severe case for this material
- **Could test 0.10 inch Polycarbonate material with different printing orientations**
  - 0.060” behaved similarly to Nylon-12 but didn’t show any difference between printing orientations
- **Need to test different infill % next**
  - Compare to Airbus testing of Ultem 9085

Questions?

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