

## **Terrapin Works RPL + AFL Nylon 12 Structural Testing**

### **Purpose:**

Both the Formlabs Fuse 1 3D printer at Terrapin Works' Research Prototyping Lab and HP 580 3D printer at Terrapin Works' Advanced Prototyping Lab use Nylon-12 for their parts. Nylon 12 is a versatile material with high detail and great dimensional accuracy. However, when comparing the final printing products together from both of the printers, the characteristics from the printing products of both printers are vastly different from each other. The fuse uses the Selective Laser Sintering (SLS) process and the HP 580 uses Multi Jet Fusion (MJF) technology. This means that the two printers have vastly different mechanical properties; by investigating certain structural properties from the ending products printed from both of these printers, it would be extremely beneficial for future customer orders from Terrapin Works and even for the 3D printing community.

### **Research Procedure:**

1. Prepare Nylon 12 to be tested for both of the two separate groups indicating the intent to compare both of the samples' results according to the instructions from both of the printers respectively.
2. Load the material into both of the printers and follow the instructions on both of the printers to print a set of dog bone test specimens for testing purposes later.
3. Put the dog bone test specimens from both printers under their own separate categories and make sure that it wouldn't get mixed up. The specimens can be easily told the difference by black/much darker gray from the formlab fuse 1 printer and much lighter gray from the HP jet fusion 580 printer.
4. Perform a range of tests to evaluate the properties, which includes tensile testing (stiffness, Young's Modulus \* cross section which gives the overall slope, tensile strength, elongation, yield strength) and bending testing. The Tinius Olsen structural testing machine in the woodshop at JMP building can be used to accomplish the tensile and bending testing processes.
5. Analyze the overall ending results of the most tests to determine and compare various parts of the material properties from both printers. One thing to point out from here is the stress-strain curve since it clearly shows the type of properties associated with the certain materials being tested. The properties will include but are not limited to modulus of elasticity, normal stress, shear stress, bending stress, strain, fatigue analysis, and deformation.

### **Tensile testing direct observations from the results:**

- 1) The HP printer material strains a lot more, and has higher both ultimate and break forces and break distance on average.
- 2) The Fuse printer material elongates a lot less per unit force than the HP material.
- 3) The Fuse printer material is also much more likely to stay in a constant shape.

**Dog Bone Sample Being Used:** ASTM D638 Type IV

**Reason:** The shape best shows the anisotropic nature for 3D printing samples due to the different properties in different directions, depending on the build and print orientation

**Tensile testing value calculations: (Young's modulus is solely based on ultimate stress)**

Test Samples	Ultimate Stress	Breaking Stress	Maximum Strain	Young's Modulus
Formlab Fuse 1 - 1	3377.5 psi (3.378 ksi)	3377.5 psi (3.378 ksi)	0.272	12.42 ksi
Formlab Fuse 1 - 2	4106 psi (4.106 ksi)	4106 psi (4.106 ksi)	0.358	11.47 ksi
Formlab Fuse 1 - 3	5198.7 psi (5.199 ksi)	5165.6 psi (5.166 ksi)	0.6	8.665 ksi
Formlab Fuse 1 - 4	3576.2 psi (3.576 ksi)	3576.2 psi (3.576 ksi)	0.296	12.08 ksi
Formlab Fuse 1 - 5	3245 psi (3.245 ksi)	3238.4 psi (3.238 ksi)	0.248	13.08 ksi
HP Jet Fusion 580 - 1	4868 psi (4.868 ksi)	4735.1 psi (4.735 ksi)	1.458	3.339 ksi
HP Jet Fusion 580 - 2	4702 psi (4.702 ksi)	4635.8 psi (4.636 ksi)	1.513	3.108 ksi
HP Jet Fusion 580 - 3	5232 psi (5.232 ksi)	5066.2 psi (5.066 ksi)	1.592	3.286 ksi
HP Jet Fusion 580 - 4	4470.2 psi (4.470 ksi)	4404 psi (4.404 ksi)	1.471	3.039 ksi
HP Jet Fusion 580 - 5	4967 psi (4.967 ksi)	4834 psi (4.834 ksi)	1.583	3.138 ksi

**Bending Testing Setup:**









