GALLOGLY COLLEGE OF ENGINEERING
SCHOOL OF AEROSPACE AND MECHANICAL ENGINEERING
The UNIVERSITY *of* OKLAHOMA

Development and Characterization of Sustainable Wood-Fiber Composite Filaments for FDM 3D Printing

Faculty Advisor: Dr. Baldwin Sponsor: Dr. Liu

2026 AME Capstone Team #9



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Project Overview and Goals

- Consistently and reliably extrude wood-composite FDM printer filament
- Design a consistent feeding system for wood fibers and PLA into the extruder
- Examine material property changes and record new material properties
- Conduct a design of experiments on material properties



Hopper Design for Increasing Pellet Capacity/Mixability

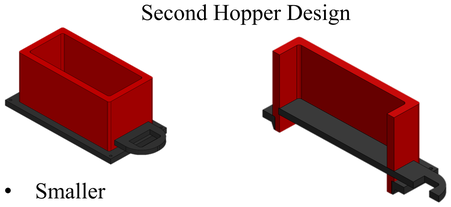
Goal: Making a hopper to mix and increase capacity of existing filament extruder hopper which holds minimum of 200g of PLA

First Hopper Design



- Compartment for wood particle and PLA pellets.
- Stop flow to extruder
- Holds 2669.4 g of additional PLA

Second Hopper Design

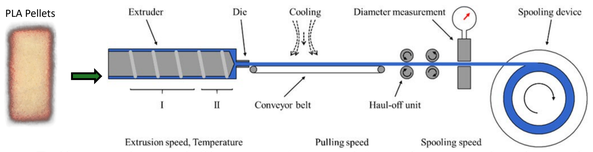


- Smaller
- Faster to print
- Holds 550g of additional PLA

Wood Manufacturing Procedure



Filament Manufacturing Process



- Pellets and wood fibers are inserted into the extruder through a hopper
- Filament is extruded at a set optimal temperature and speed depending on material
- Filament is pushed through a die with a hole diameter of 1.75mm
- Convection cooling fans harden filament
- Filament is compressed and spooled

Image Credit: https://www.researchgate.net/figure/Schematic-diagram-of-filament-production_fig5_356372395

Filament 3D Printing Profile

Table 1: Wood-Plastic Composite (WPC) 3D Printing Profile

Filament	Diameter	1.75	mm
	Density	1.14	g/cm^3
Temperature	Nozzle	200	°C
	Bed	60	°C
Speed	Perimeters	170	mm/s
	Infill	200	mm/s

Tensile Testing Process

- Tensile test specimens (dogbones) are 3D printed using the profile in table 1
- Actual dimensions are obtained for specimen cross sectional area (in^2)
- Dogbones are loaded into Instron Tensile testing machine, ensuring perfect vertical orientation using level
- Extensometer is placed on dogbone for strain reading
- Instron is set to output time (s), force (lbf), and strain (in/in)
- Test is started
- Data is output and transformed to stress, elastic modulus, and Ultimate Tensile Strength (UTS)

ASTM D638 Type II Tensile Test Specimens



PLA **Beech** **Red Oak** **Walnut**

- 1% and 2% by mass wood/PLA specimens
- Maximum wood particle size of 212 µm and 150 µm
- 3 specimens of each individual makeup
- 18 specimens were tested on Instron tensile testing machine
- DoE was used to interpolate remaining 12 specimen's UTS

Results

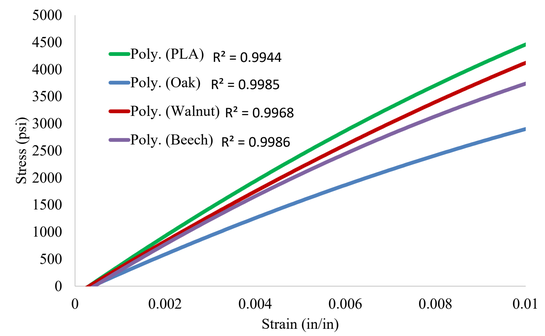


Figure 1: Stress/Strain Summation of Different Wood Types

Table 2: Composite Ultimate Tensile Strength Summary

Material	Title	Wood %	Max. Wood Size (µm)	UTS Avg (psi)
PLA	N/A	N/A	N/A	7346
Red Oak	O1_70	1	212	7131
	O1_100	1	150	5325
	O2_100	2	150	7499
Walnut	W1_70	1	212	7192
Beech	B1_70	1	212	5872

Design of Experiments

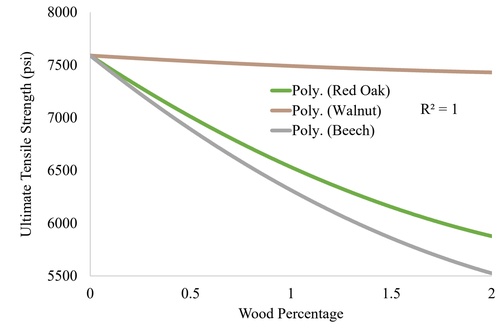


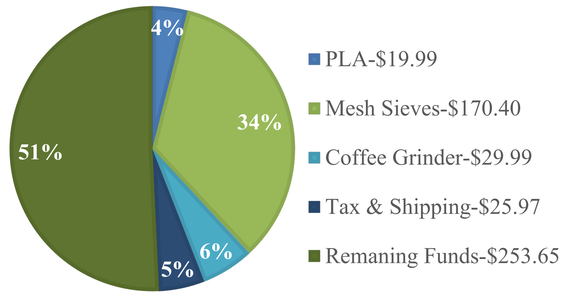
Figure 2: Wood percentage by Mass Effect on UTS

Conclusion and Impact

- Increasing wood fiber content reduces tensile strength, with PLA showing the highest UTS
- Red oak and Walnut composites outperform Beech at similar compositions
- Improved hopper design gives more capacity for Mixture
- Supports use of wood-PLA composites for sustainable, low-load 3D printing applications
- Biodegradability is better for the environment

Budget Allocation

$500 of department level funds allocated



Codes and Standards

- ASTM D638 Type II Test Specimens
- ASTM E11 (Sieve Cloth, Compliance, and Calibration)
- ASTM E323 (Perforated Plate with Round/Square Aperture)
- ISO 3310 (Aperture Sizes from 125 mm to 20 µm)