

# Investigation of Tensile Strength of 3D Printed Materials

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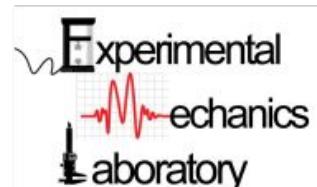
Young Engineer Experience Scholar

Experimental Mechanics Laboratory, Mechanical Engineering  
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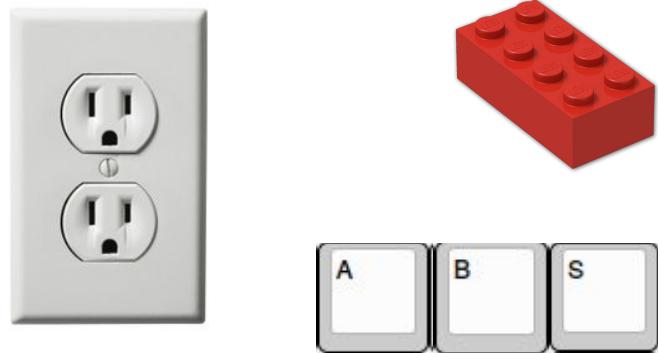
Summer Final Progress Review, July 10<sup>th</sup>, 2019



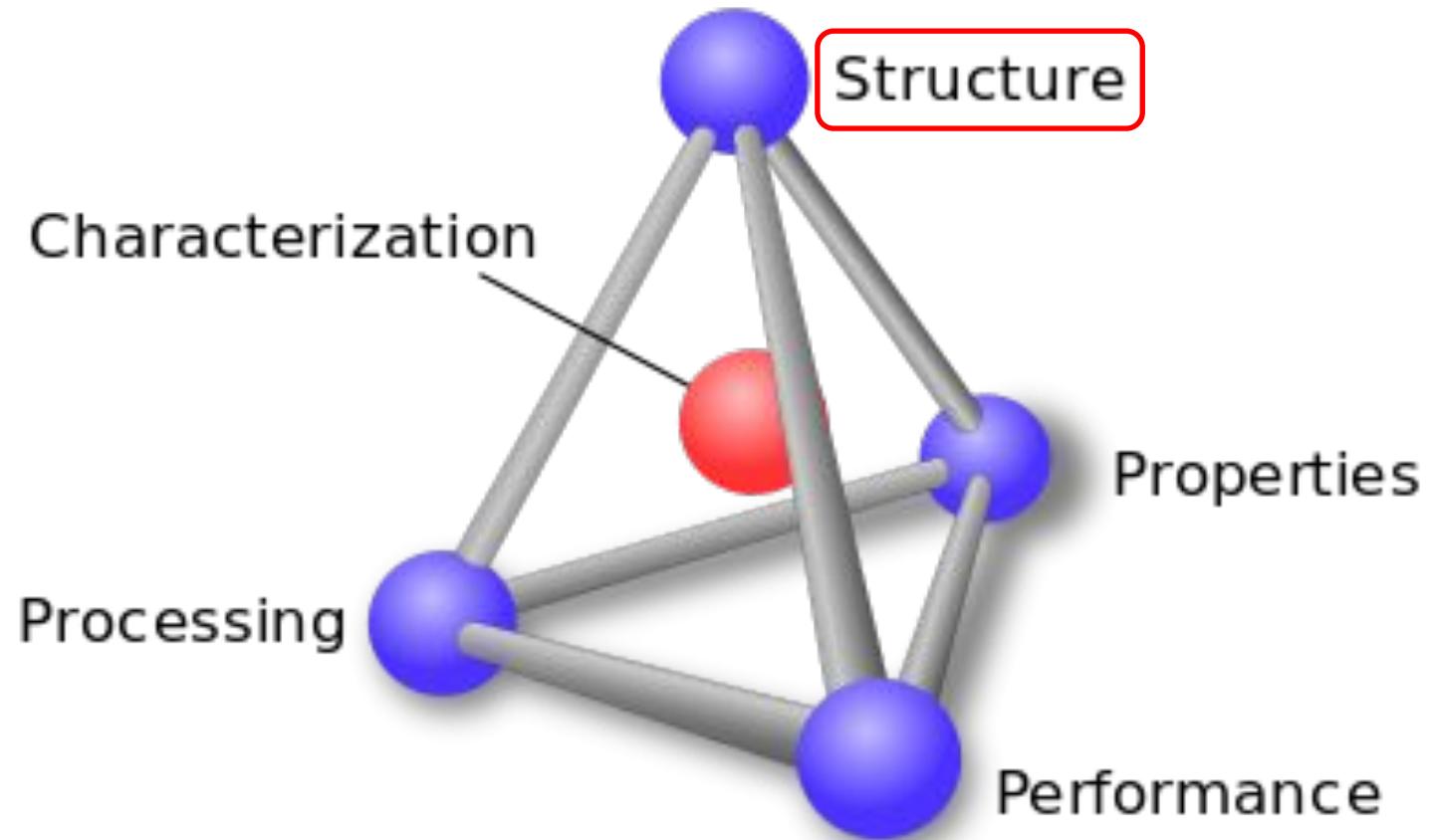
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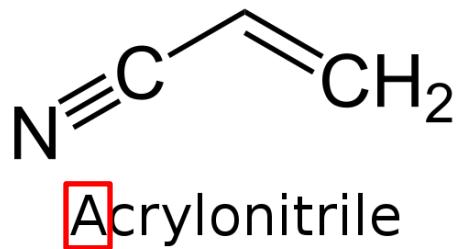


- Acrylonitrile Butadiene Styrene (terpolymer) – thermoplastic
- Typically used in injection molding (e.g., legos, computer keys, outlet covers)
- Common 3D Printing filament
- Mechanical and Physical Properties

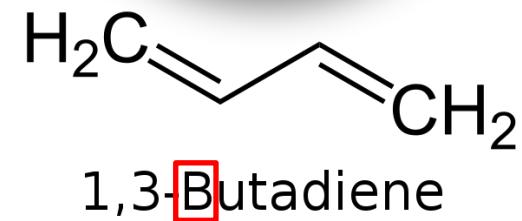


Property/Attribute	ABS	PLA
Melting Temperature	204 - 238 °C	150 - 180°C
Glass Transition	100°C	60°C
Tensile Strength	46	50-70
Elongation	40%	4% - 7%
Fumes	Intense	Little/None

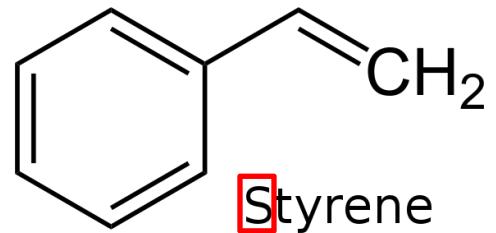




Heat  
resistance



Glossy  
surface and  
rigidity

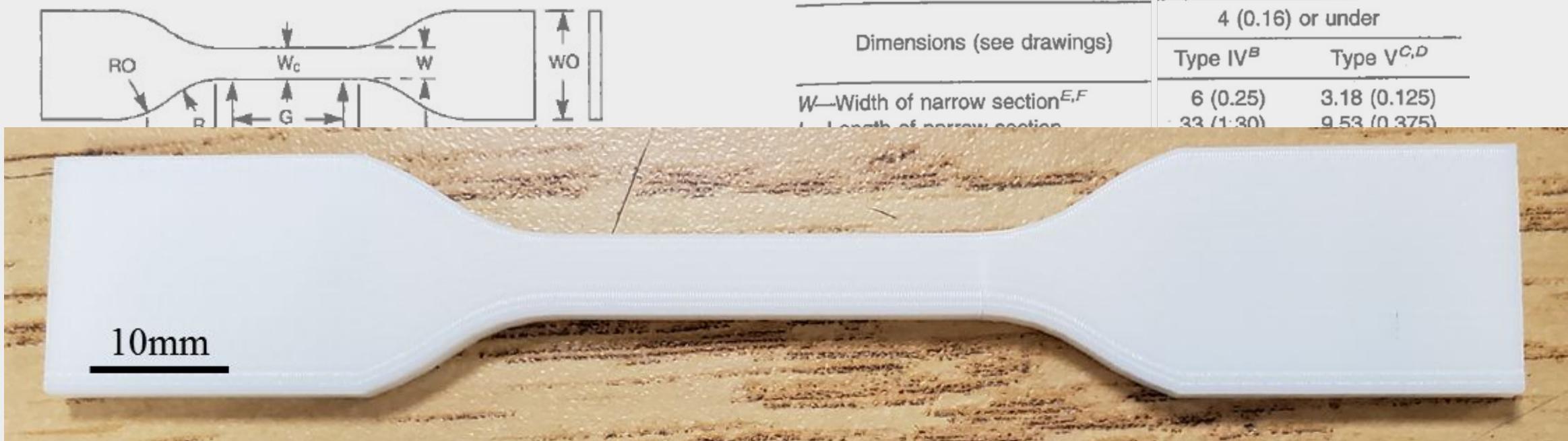


Impact  
strength and  
resilience



For the purpose of this study, the effect of processing parameters are investigated using ABS

- Sample geometry modeled in accordance to ASTM D638-14



- (5) orientations
- Print quality was set to ‘Solid’  highest density to reduce the air-gap between printed beads



## Material Preparation



Cleaned Mold  
Surfaces with IPA



## Mold Preparation

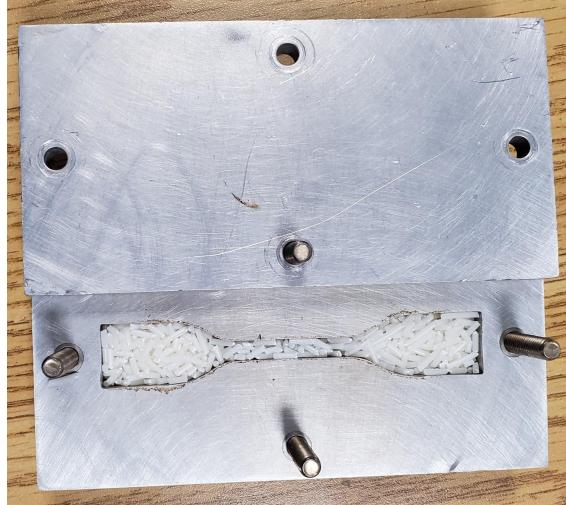
## Challenges/Improvements



6.1g @ 240°C for 3h



6.1g @240°C for 3h



6.8g @ 220°C for 3h



Sample burned and charred

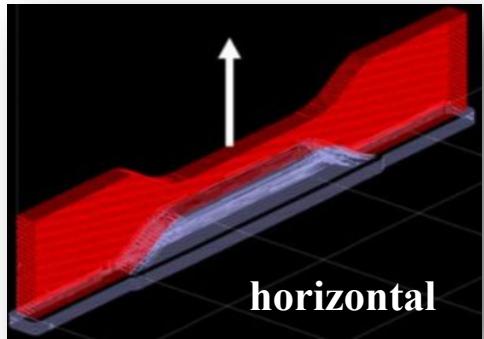


Adding a copper-cover  
reduced charring



Over-filling + full covered  
results in good sample

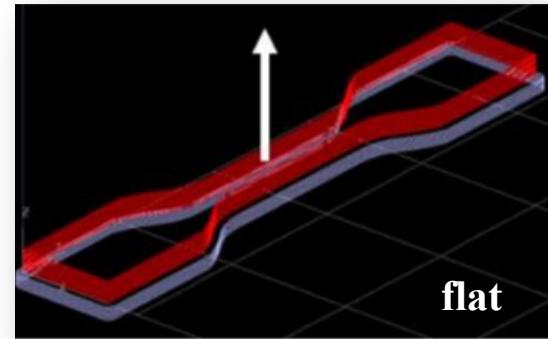
- 3D Print ABS ASTM D638 Type IV samples in **horizontal**, **vertical**, and **flat** orientations



horizontal



vert.



flat

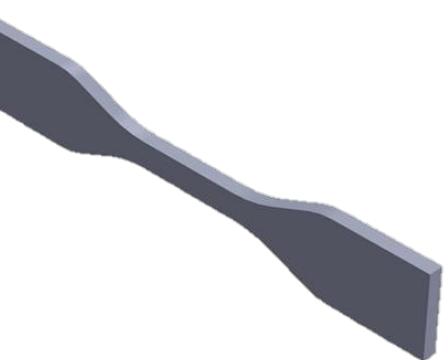
- Design a **mold** to fabricate molded ASTM D638 Type IV samples to benchmark the properties (*discussed next*)
- Physical **testing** in accordance to ASTM D638-14 to report the **tensile** behavior

Print

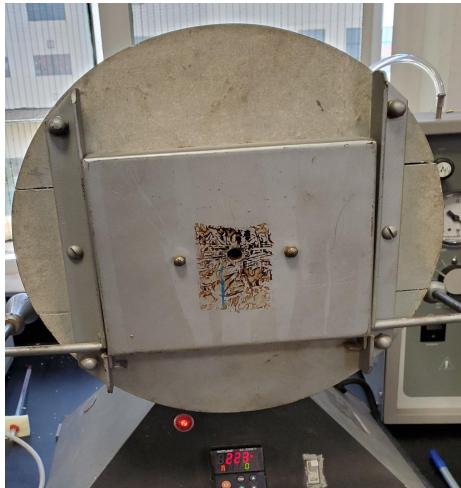
Mold

Test

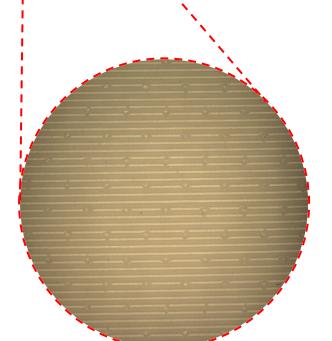
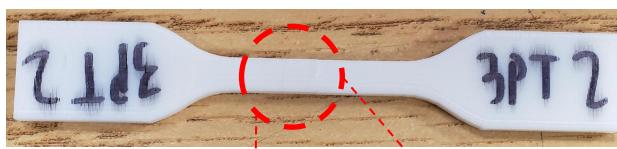
# Experimental Approach



**uPrint SE**



**High Temp Oven**

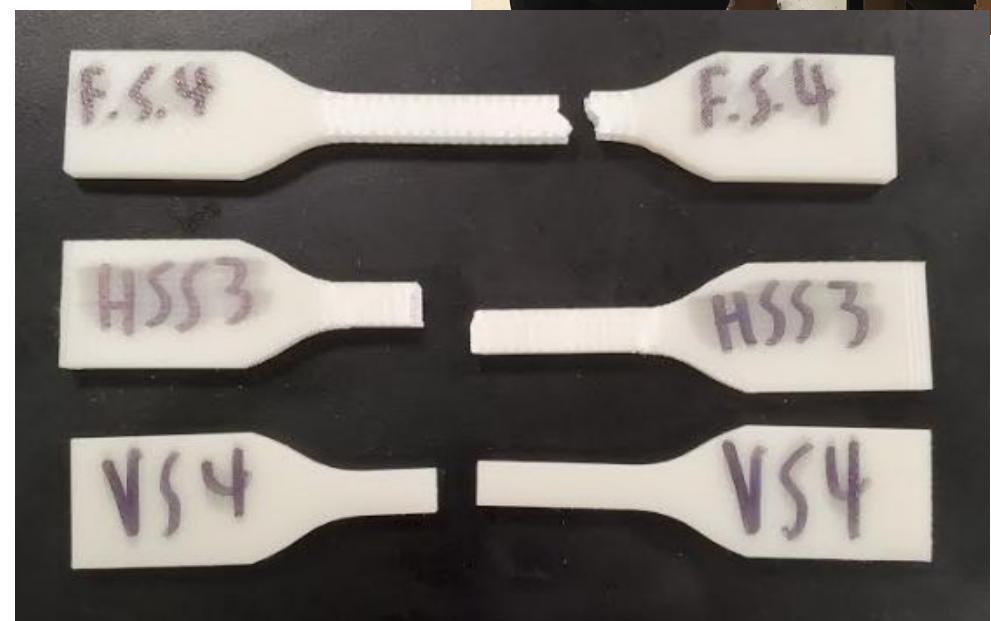
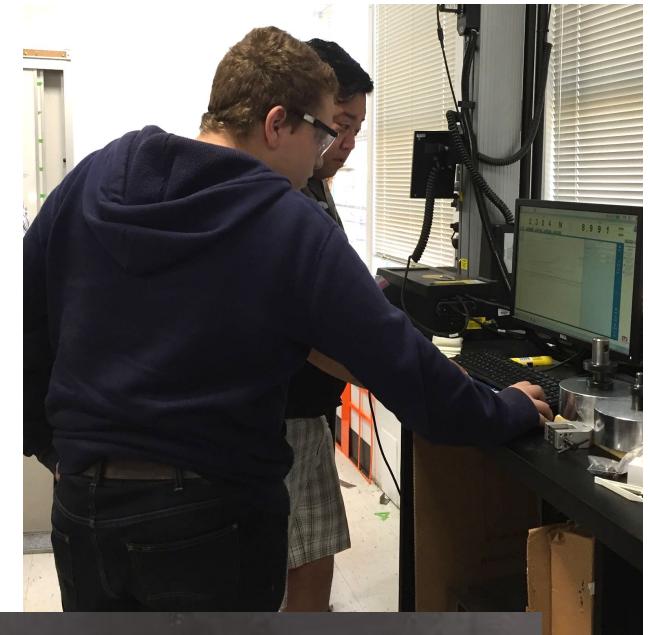


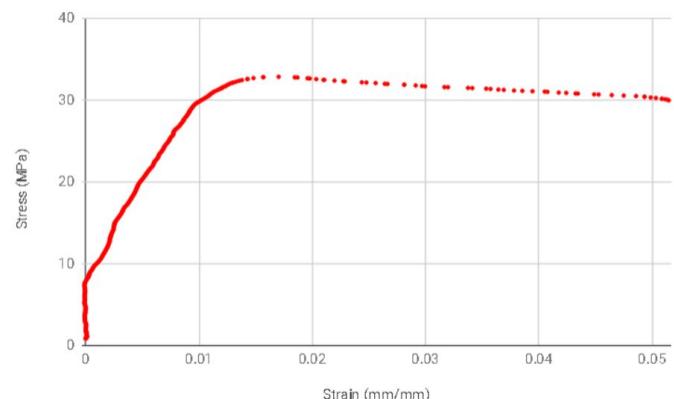
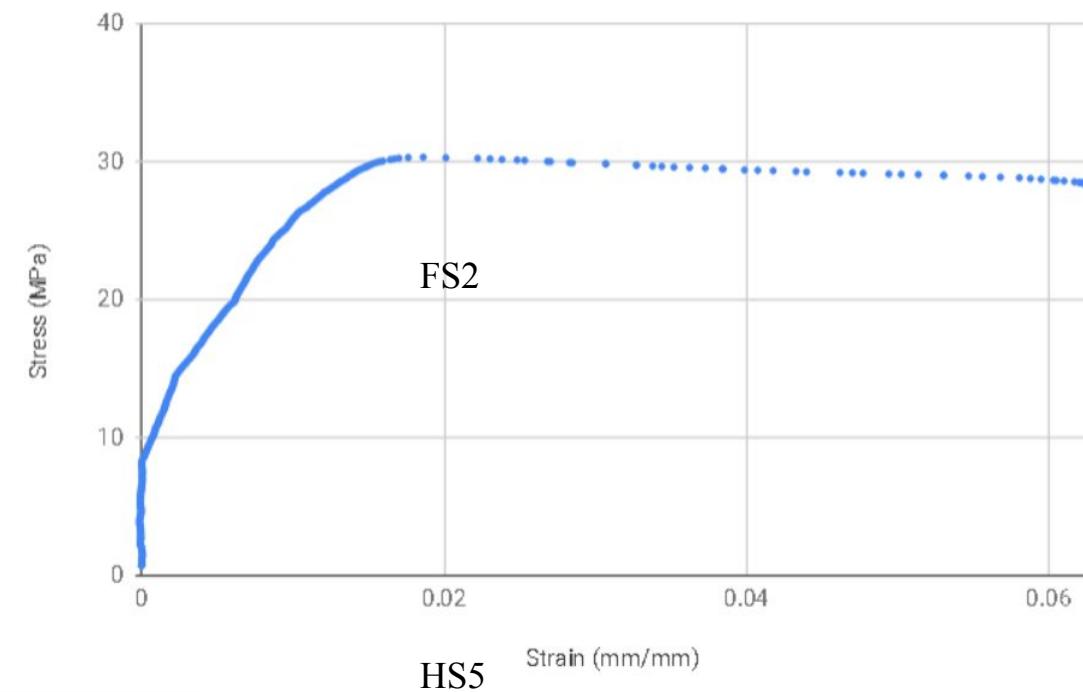
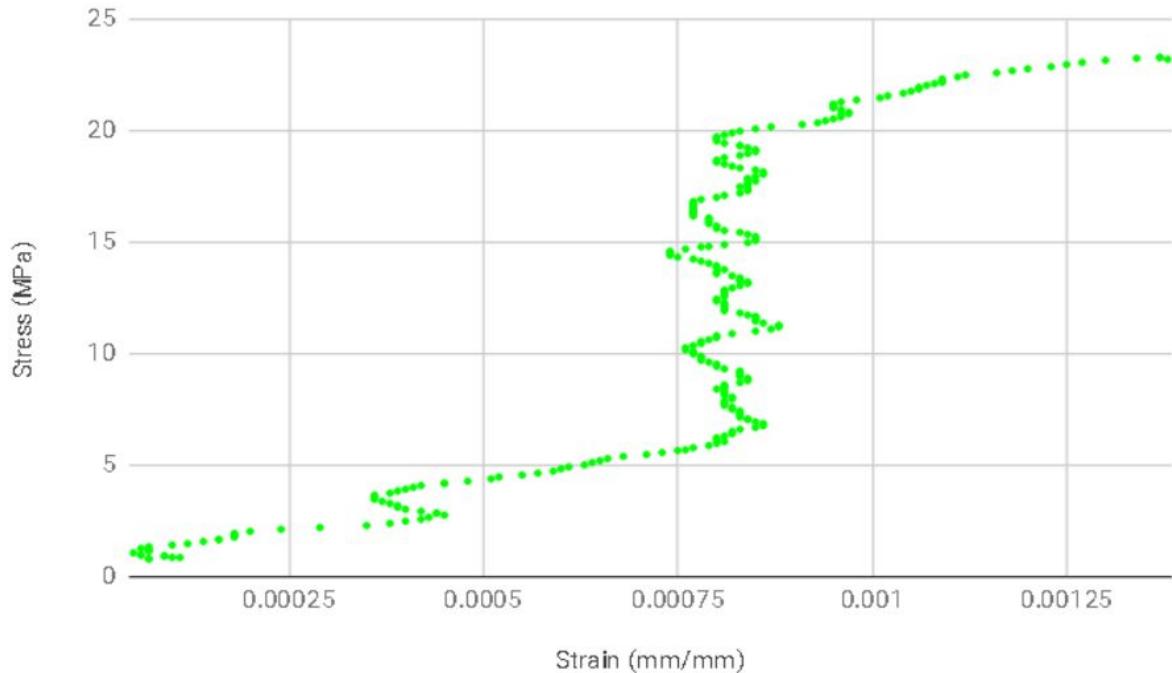
**Testing  
Machine**



**Failed  
Sample**

# Tensile Testing





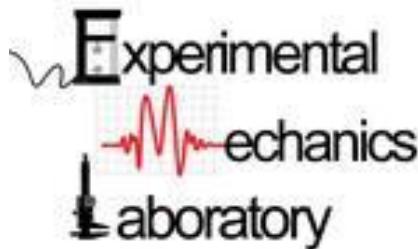
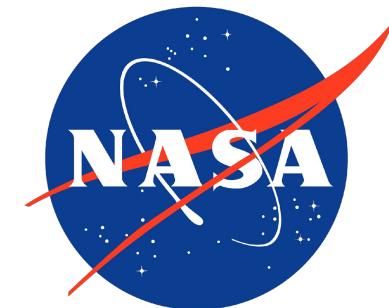
VS4

Test	Average (SDev)		
	Sample	Strain to fracture (%)	Tensile Strength (MPa)
Vertical		0.72 (.0044)	19.13 (12.7)
Flat		7.88 (.016)	30.43 (1.03)
Horizontal		3.26 (1.45)	32.55 (1.6)

- Good idea to accommodate for 3D printing process duration
- Process design and improvement takes time
- When preparing ABS for a mold, it is better to cut it into small pieces
- The application of adhesion spray is very important
- Time management should be a priority
- Molding is much more efficient than 3D printing, and although it may take longer, the product has a higher tensile strength

- Feeling welcomed into the lab
- Given freedom to use the lab equipment for the project
- Given trust to work in the lab
- Being invited to activities outside the lab
- Given a glimpse of the life of a student working in the Experimental Mechanics Lab

# Thank you for your attention!

 Experimental  
Mechanics  
Laboratory**JPL****SAN DIEGO STATE  
UNIVERSITY**