# PLA Water Bottle

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## GOAL

**To replace all Polyethylene Terephthalate (PET) Disposable Water Bottles with Polylactic Acid (PLA) material**

### Abstract

There are many environmental consequences such as pollution and climate change exacerbated by Polyethylene Terephthalate (PET), also known as plastic. PET water bottles, specifically, are a significant source of pollution on the planet. Our Grand Challenge Initiative aims to lessen the environmental consequences caused by plastic bottles by finding an alternative. Polylactic acid (PLA), a bioplastic, shares similar characteristics to PET, making it a great potential substitute. In the past semesters, the attributes of Polylactic Acid were tested in two home experiments focusing on how PLA reacts to varying pH levels and different environmental conditions. Even more, a PLA water bottle prototype using a 3D modeling program, Tinkercad, was created and then brought to life using the Makerspace 3D printers. The results of the experiments were that PLA could withstand a broad spectrum of pH levels and environmental conditions. This project is very significant because it introduces replacing all PET water bottles with Polylactic Acid, an action that promotes sustainability and environmentally friendly solutions.

### Grand Challenge - Plastic

- Air and Water pollution
- Oil Spills
- Climate Change
- Disposal Issue
- Animal and Human consequences

### Method

- Experiment 1
  - Two environments (inside and outside)
  - Liquids: Coca Cola (pH:3), Bleach (pH:11), Water (pH:7)
- Experiment 2
  - Four environments PLA bottle may encounter
  - outside, refrigerator, room temperature, bathroom (humid)
- Tinkercad
  - Used to build 3D model of prototype
  - 3D model made of PLA material

### Conclusion

- Understand the devastating effects of plastic on our planet
- Understand the difference between PET & PLA
- Why PLA is a good candidate for a PET replacement
- We hope that larger scaled companies will be inspired to change their manufacturing habits

### Experiment - PH, Outdoors

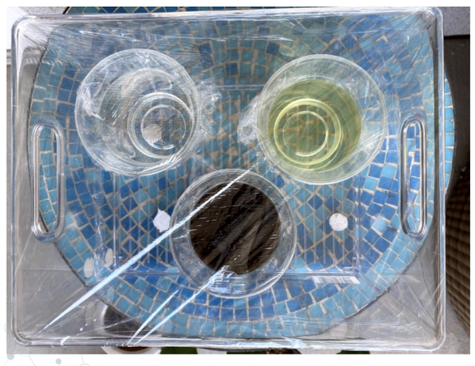

Figure 1: PLA cups with Coca Cola, Bleach and Water. This experiment tested out how pH affects PLA in an outdoor environment.

### Experiment - PH, Indoors

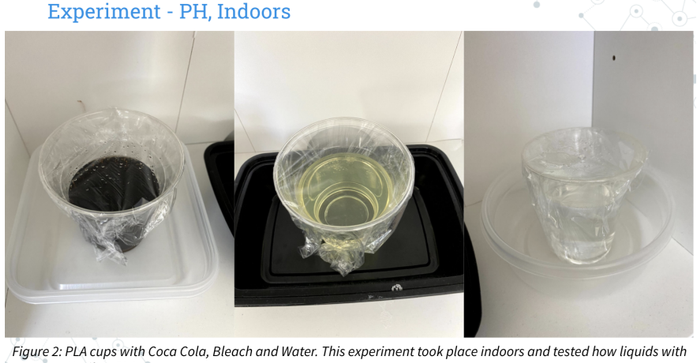

*Figure 2: PLA cups with Coca Cola, Bleach and Water. This experiment took place indoors and tested how liquids with varying pH affect PLA.*

### Experiment - Environment

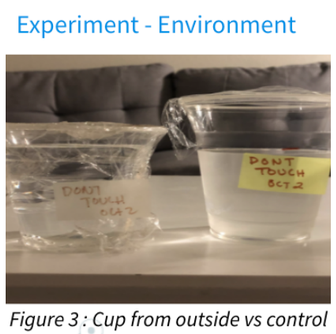


*Figure 3 : Cup from outside vs control cup for the environment experiment.*

### Virtual Prototype

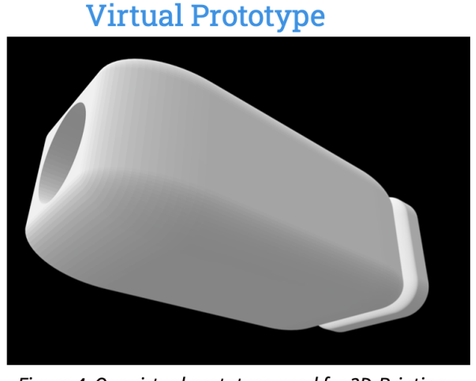

*Figure 4: Our virtual prototype used for 3D-Printing.*

### PLA Prototype

*Figure 5: 3D printed PLA water bottle prototype made in makerspace.*

## Interview with Joe Jankowski @ Corbion PLA

Corbion PLA:

- Makes resin PLA pellets
- Does not make lactic acid, but polymerizes lactic acid
- Sells pellets to other companies to make products
- markets with “closed loop scenarios”

***Disposal of PLA is the biggest challenge***

- Why “closed loop” scenarios are necessary
- Cannot be recycled at regular recycling facility
- Does not degrade at landfill
- Requires anaerobic digestion to degrade properly (specific temperature and times)

## Roadblocks

- Very few PLA production companies in the US
- COVID-19 limited access to supplies, tools, and equipment

### Citations:

Kucharczyk P, Pavelková A, Stloukal P, Sedlarík V. 2016. Degradation behaviour of PLA-based polyesterurethanes under abiotic and biotic environments. Polymer Degradation and Stability. 129:222–230. doi:10.1016/j.polymdegradstab.2016.04.019.

Madhavan Nampoothiri K, Nair NR, John RP. 2010. An overview of the recent developments in polylactide (PLA) research. Bioresource Technology. 101(22):8493–8501. doi:10.1016/j.biortech.2010.05.092.