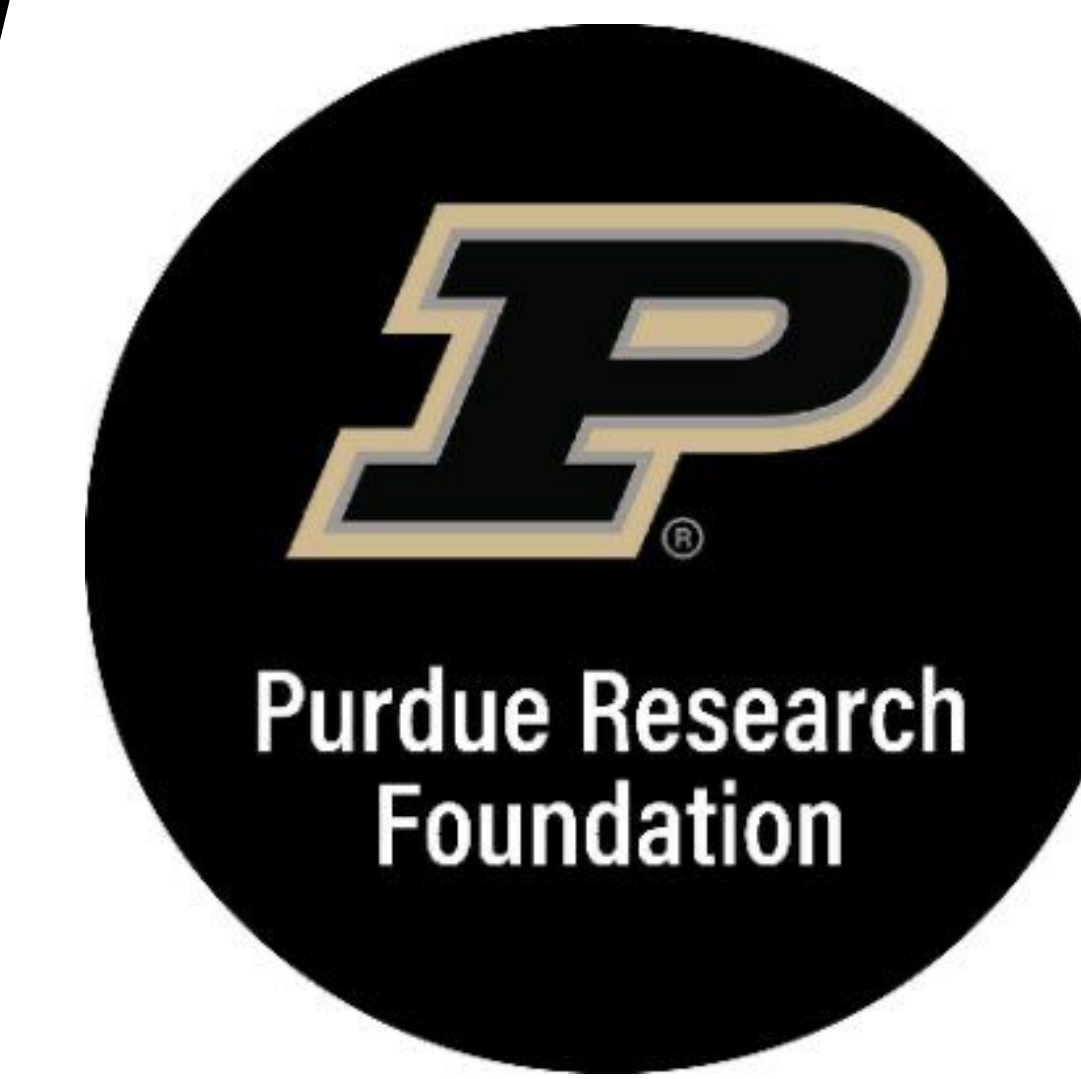


# Photocatalytic PVA Filter

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Mentors: Dr. Fred Berry, Dr. James Condron, Prof. Charles Steele



## Problem Statement

We want to generate a product that will degrade PVA products used in household appliances to reduce the amount of microplastics that flow into public water systems. Our goal is to innovate an installable addition to either a dishwasher or washing machine that can neutralize the majority of microplastics. The intent is to develop a commercialized product that can be integrated into existing appliances or attached as an external unit by the consumer.

## Customer Background

The Purdue Research Foundation serves as the primary customer and sponsor for this project, which addresses the environmental contamination caused by the pods used in household washing machines and dishwashers. The ultimate goal is to reduce or eliminate polyvinyl alcohol (PVA) from these pods before the contaminants reach our waterways. To achieve this, the project focuses on designing an end-user device that utilizes a photocatalytic process and can be easily integrated into residential washing machines, and dishwashers. The stage of the project we were tasked with was testing the viability of the photocatalytic process to prove the underlying science.

## Requirements

Req. #	Design Elements	Design Targets	Validation
1	UV Light	UV Range 380-395nm	Y
2	Catalyst Beads	Degrades PVA into CO2 and H2O	Y
3	Venturi Valve	Infuses air into water inflow	Y
4	Water Pump	Cycle water through system	Y
5	Aerator	Provides air for venturi valve	Y
6	Water Reservoir	Stores PVA solution	Y

Table 1. Materials, parts, and their functions listed as needed.

## Experimentation and Concepts

Our team began experimentation by developing a basic proof-of-concept design to deconstruct and evaluate each component of the system. A five-gallon bucket served as the initial reservoir, paired with an aquarium-grade UV filtration system and a selected catalyst to support PVA degradation. The process relied on a chemical reaction, including ultraviolet exposure, oxidative polymer breakdown, and an acidic PH.

After validating the initial concept, we transitioned to a more robust and engineered design with improved material selection and a more repeatable, user-friendly system architecture. The final phase focused on extensive testing to better understand degradation rates, process efficiency, and overall system performance.

## Final Design

Our final design for testing consists of two main parts. The paint can acts as a water reservoir, simulating the washing machine environment. The catalyst chamber holds catalyst beads and UV lighting, main sources of PVA degradation, to dissolve PVA in the water.

A water pump inside the paint can pumps the PVA solution to the catalyst chamber through connected hoses. The degradation process requires aeration and venturi valves were installed in the input hoses with air pumps. We have a total of 3 systems installed to do 3 tests at once with different solutions.

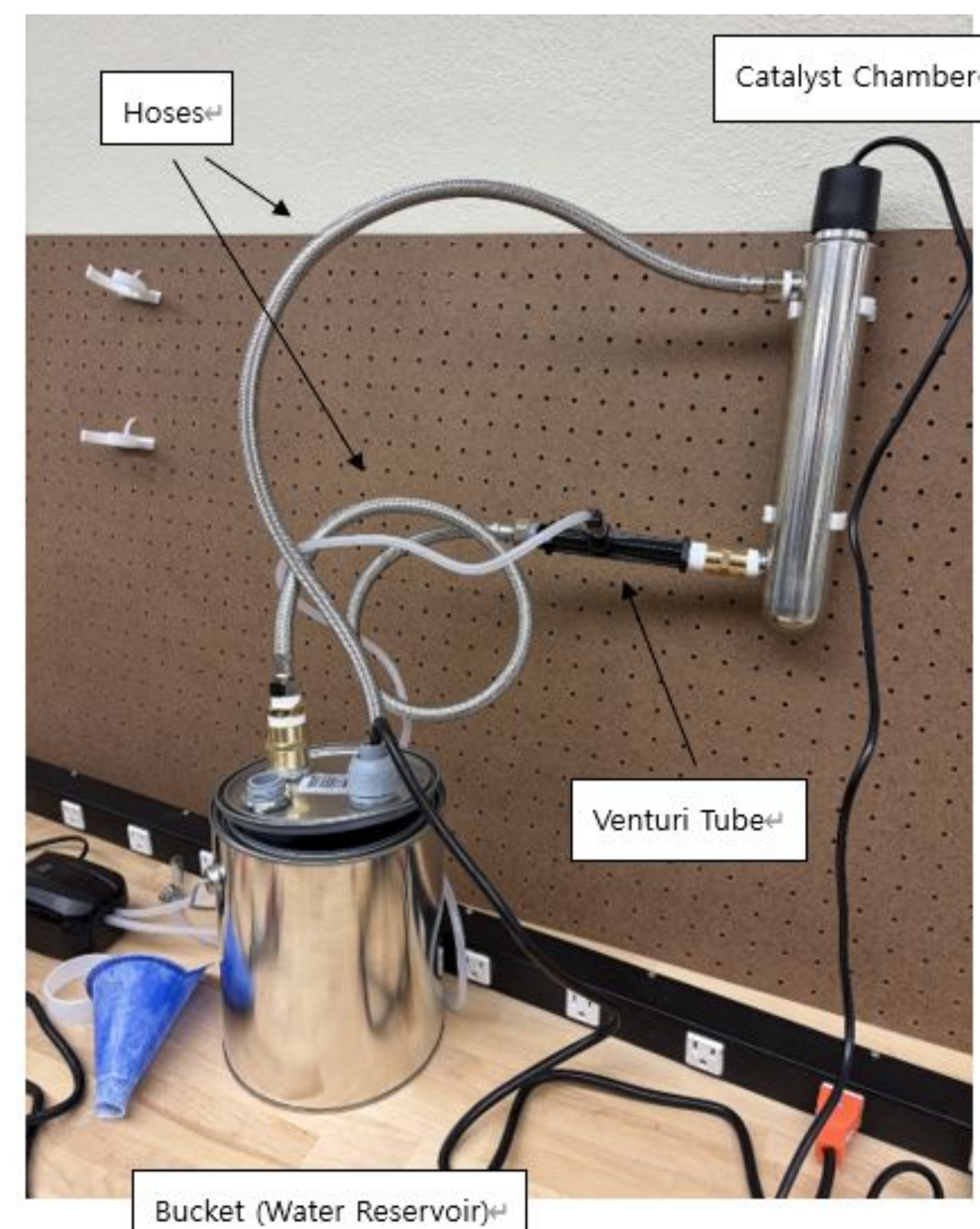


Figure 1. Displays one of the three testing prototypes and the main components.

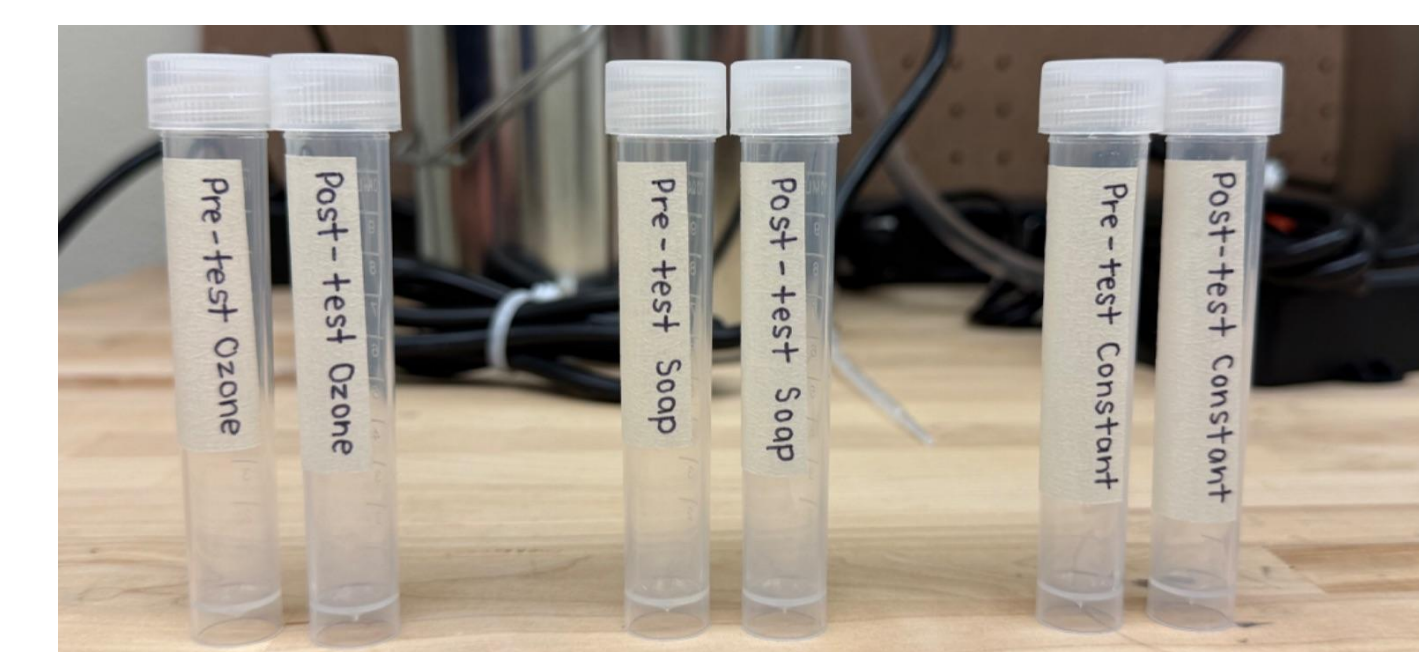


Figure 2. Displays collected test samples.



Figure 3. Displays all three prototypes that are at West Lafayette.

## Testing and Results

Credits to Sadie Bielski, PNW on testing and results

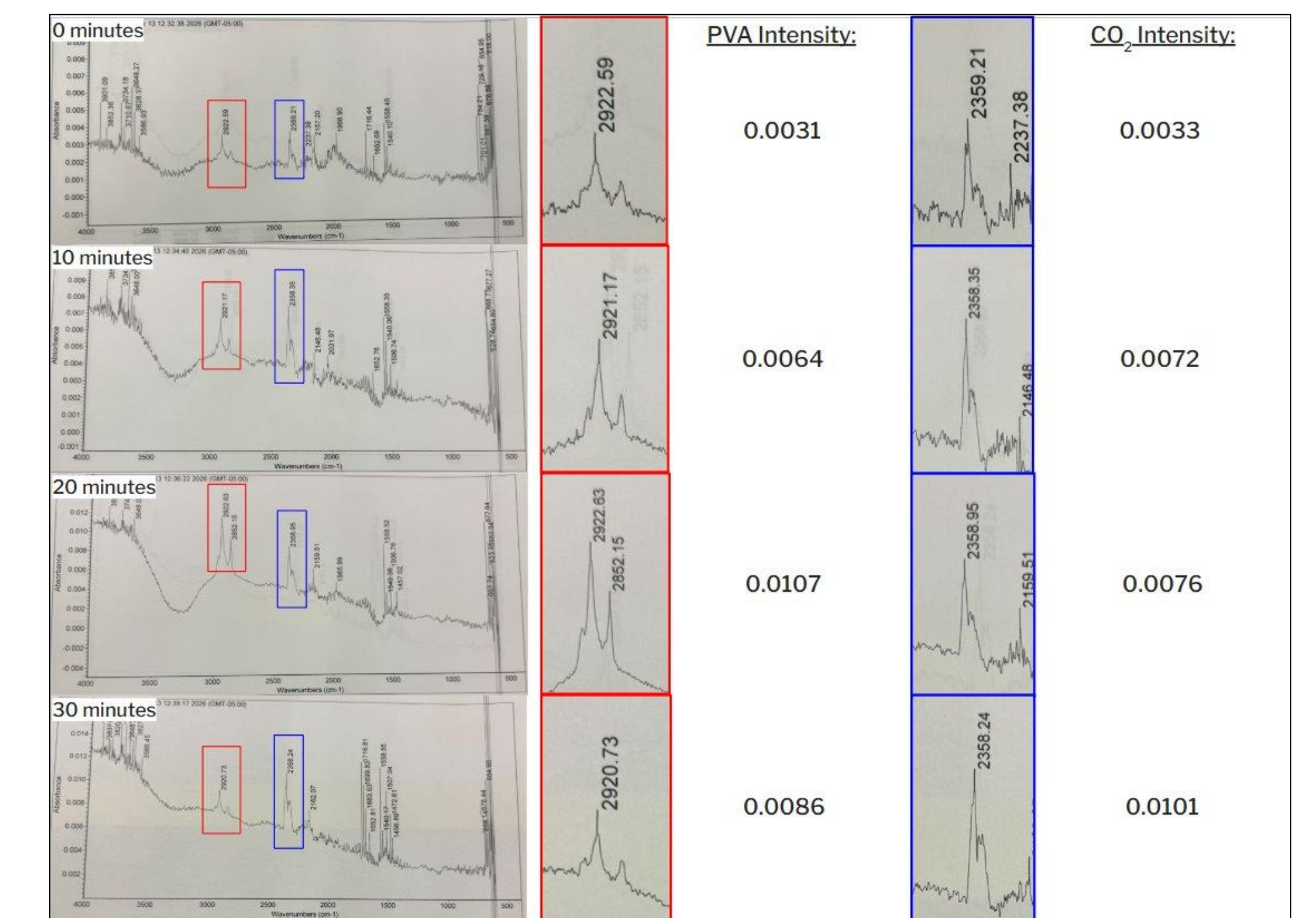


Figure 4. Side-by-side comparison of Trial 3 samples over time results from IR spectroscopy highlighting the PVA and CO<sub>2</sub> peaks.

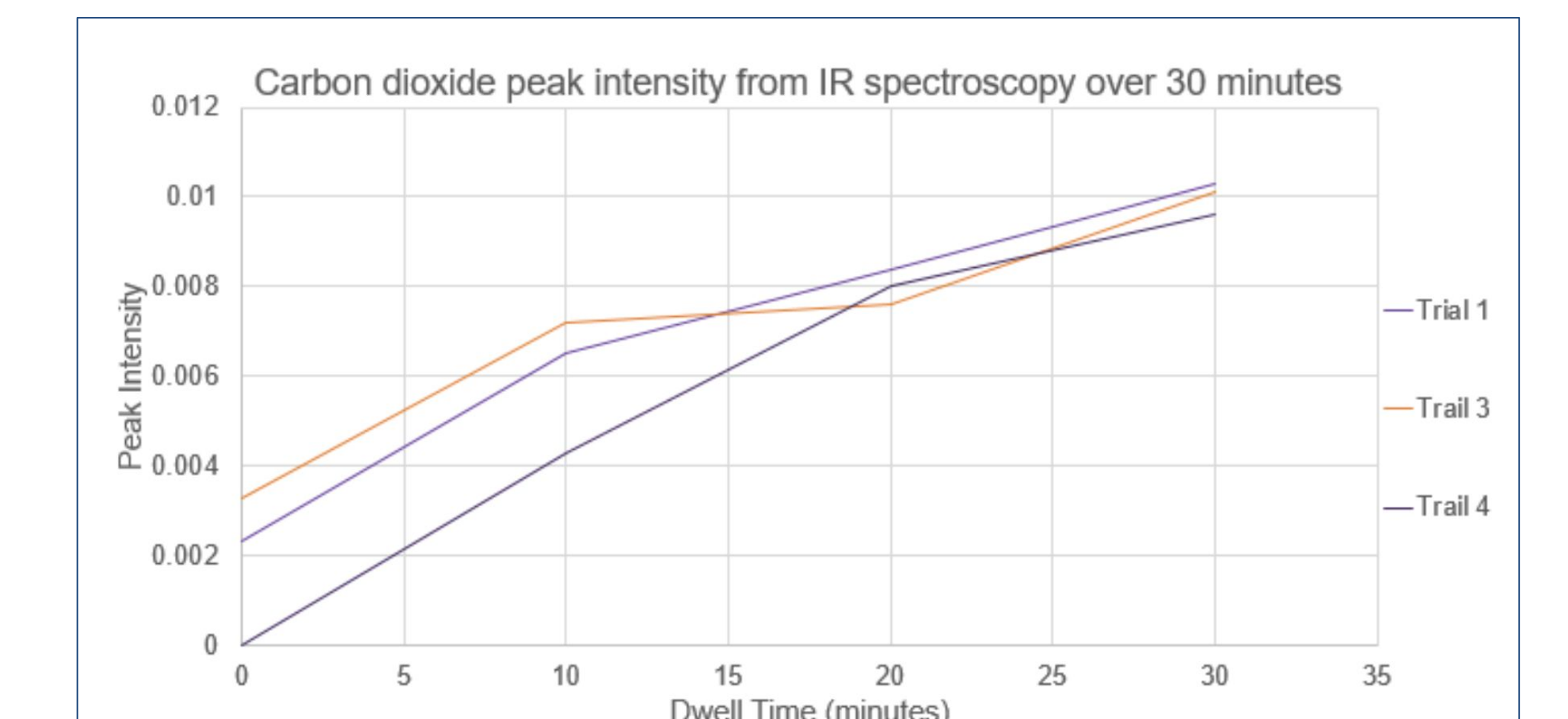


Figure 5. Graph showing the general increase of carbon dioxide peak intensity over a 30-minute dwell time for each trial excluding Trial 2.

The degradation of PVA from detergent pods containing PVA casings such as Tide Pods is possible using photocatalytic reactions in a 30-minute time constraint. The production of carbon dioxide during dwell time proves that the desired reaction is happening and PVA is being broken down. The PVA peak increasing before decreasing is due to the PVA going into solution as the diluted Tide Pod dispersion is running in the prototype. From the IR spectroscopy data showing that the baseline is decreasing over time, it can be concluded that the components of the Tide Pod are being broken down over time as well. This research project has supported provisional patent 63/836,769.

Future work that is to be accomplished before the end of the semester is making the prototype currently used for testing into an actual product that can be used with washing machines to remove PVA from water.