



# Valorization of Biomass Derivatives to Monomers by M-MO<sub>x</sub> Catalytic Hydrogenation & Hydrodeoxygenation



University of New Hampshire

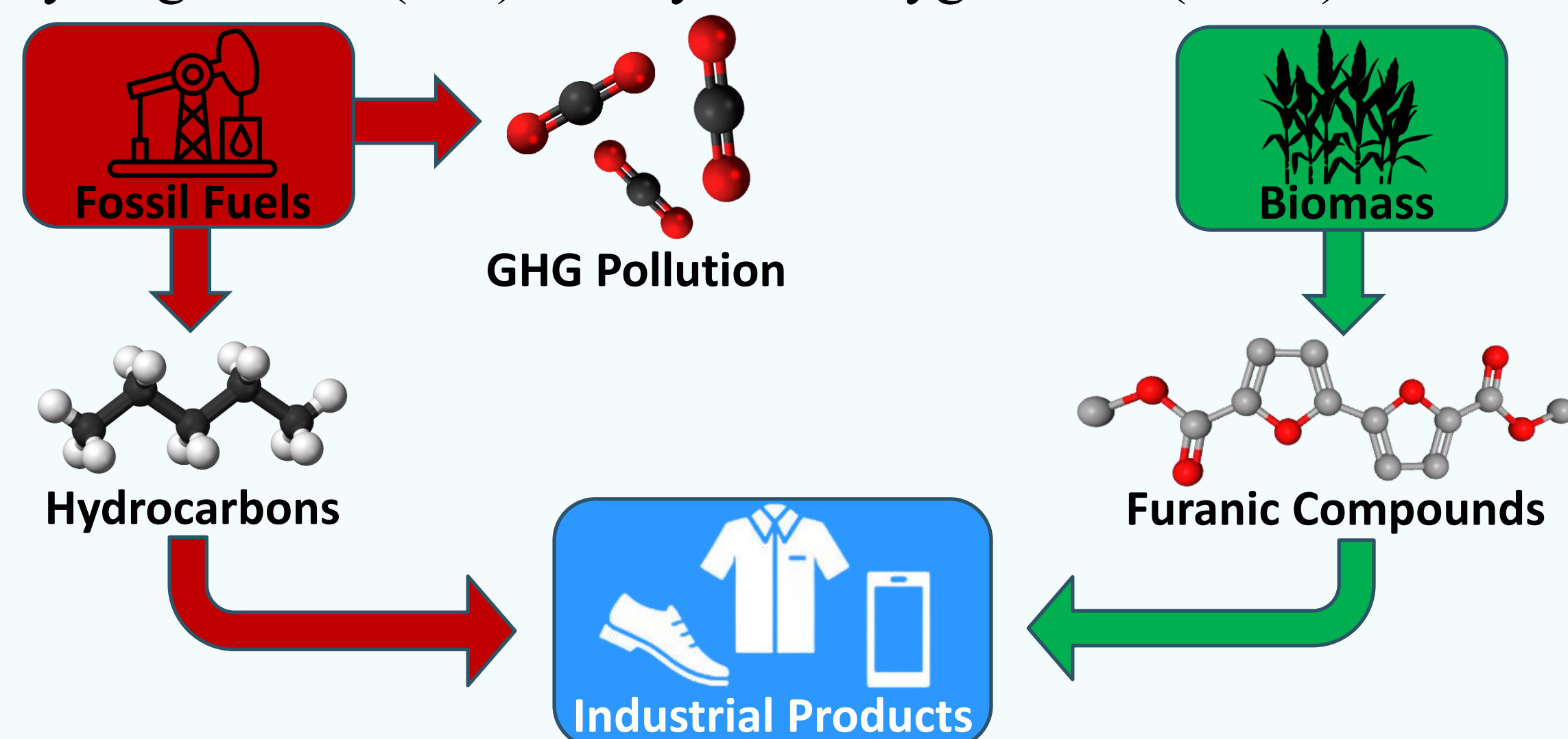
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## Introduction

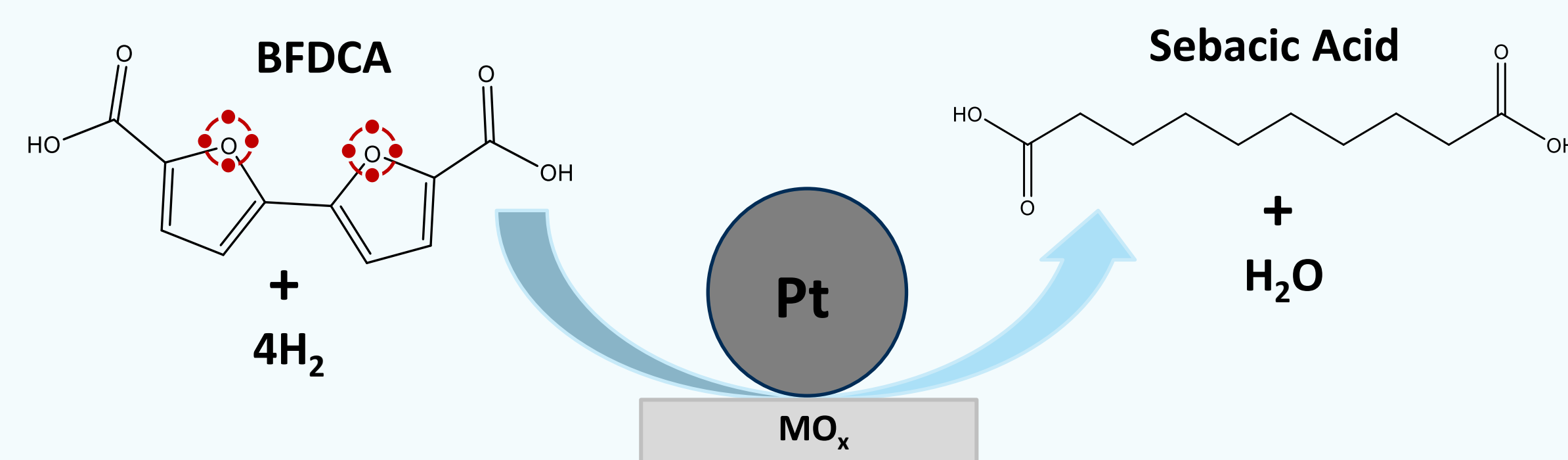
- Petrochemical production is unsustainable and environmentally detrimental, causing pressing global issues.
- Biomass residues from agriculture could be converted into feedstocks for petrochemicals by 2-step M-MO<sub>x</sub> catalyzed hydrogenation (HG) and hydrodeoxygenation (HDO).



- Biomass derived 2,2'-Bifuran 5,5'-dicarboxylate (BFDCM) was evaluated for upgrading to the monomer Sebacic acid (SA), a feedstock for nylons, polymers, adhesives, and lubricants.

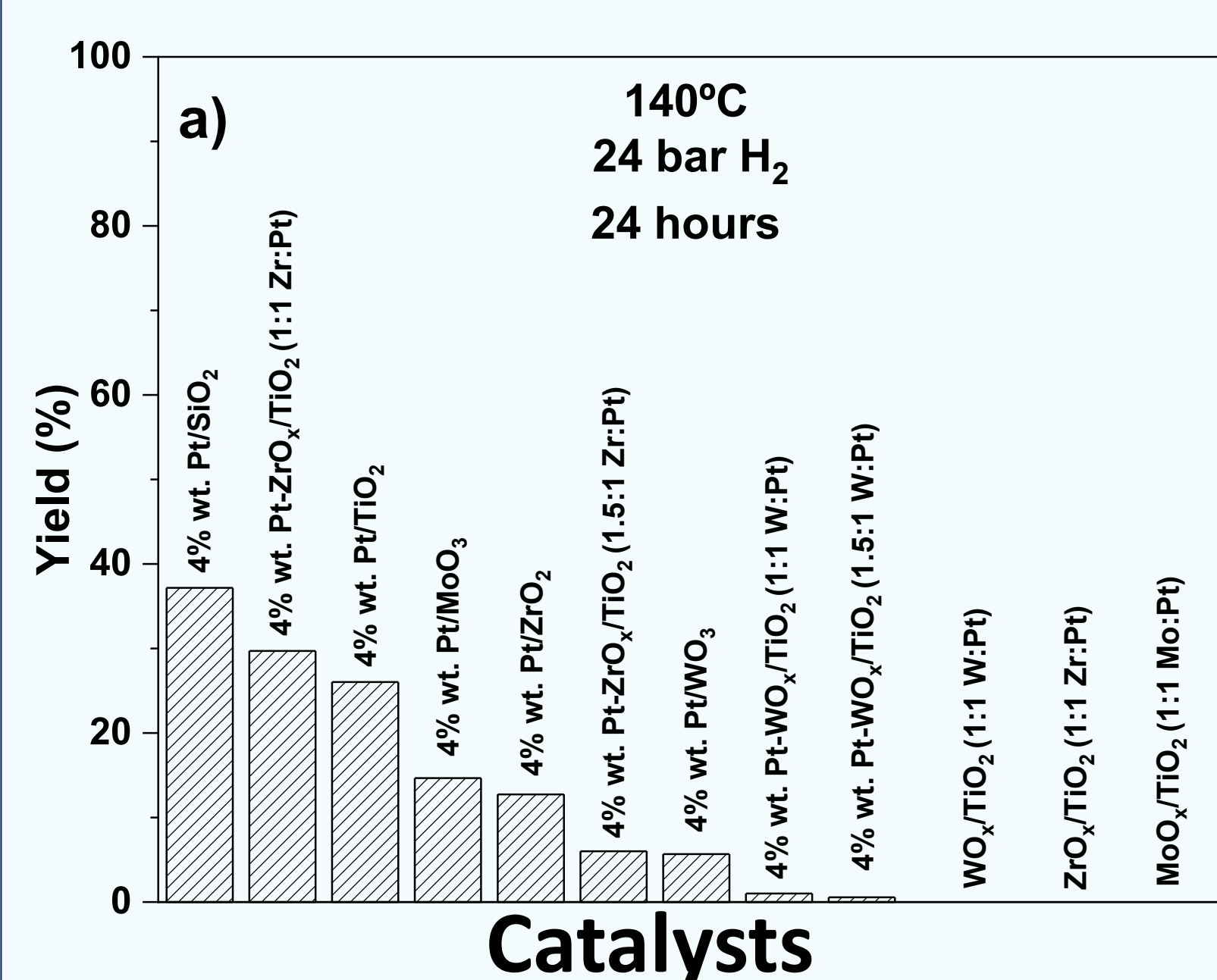
## Background

- 2-step conversion of furan 2,5-dicarboxylic acid exhibited high yield in ring-opening and HDO by supported M-MO<sub>x</sub> catalysts.
- SA production via 1-step conversion by M-MO<sub>x</sub> catalysts from 2,2'-bifuran 5,5'-dicarboxylic acid (BFDCM).



## Prior Work

### 1-Step HDO of BFDCM



- 37% Yield on 4% wt. Pt/SiO<sub>2</sub>
- Pt is essential for Sebacic Acid selectivity.
- Hard-to-reduce supports show higher selectivity.

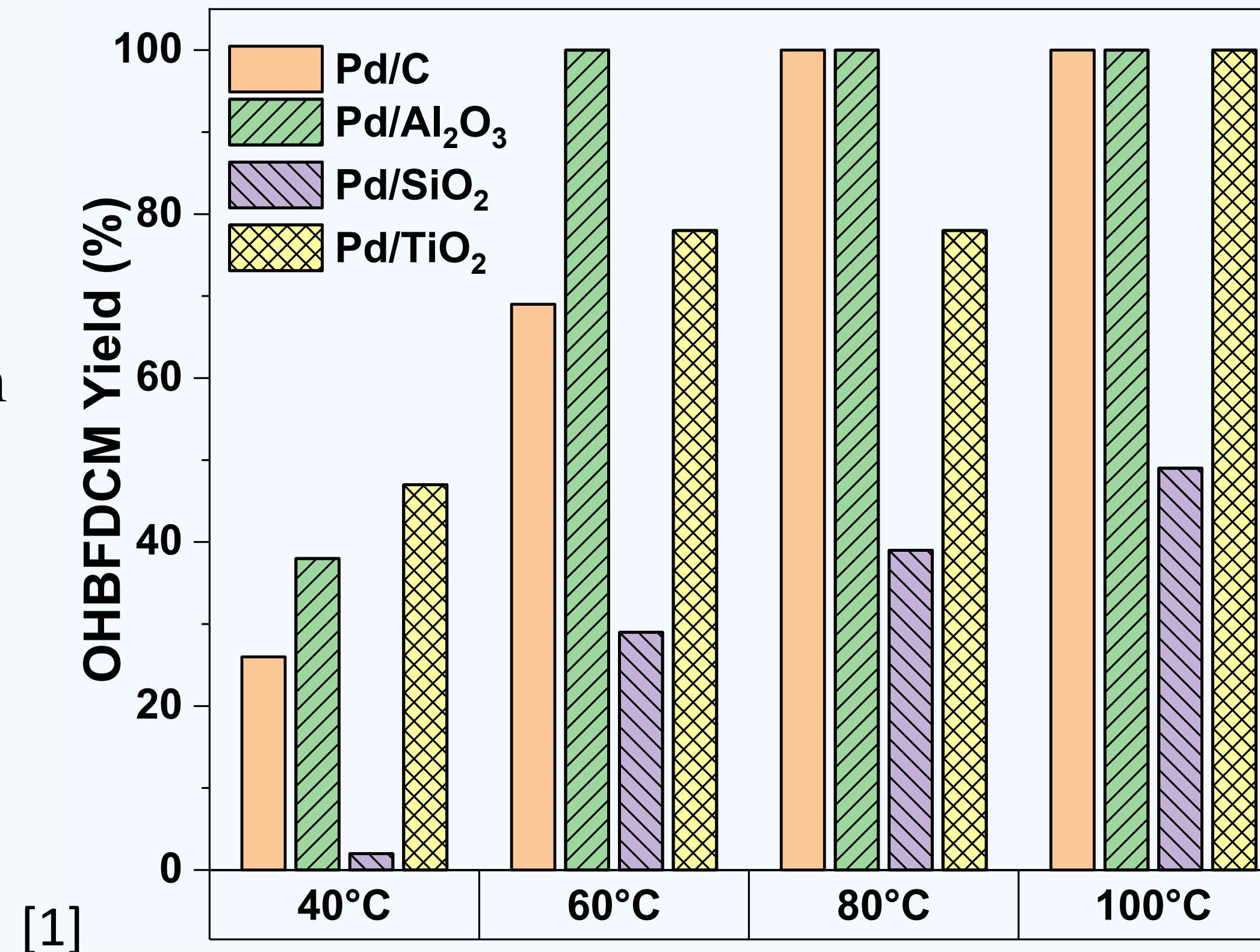
## Hydrogenation Activity

### Activity testing:

- Increasing reaction temperature increases yield across all catalysts.
- Catalyst support may play a role in catalyst activity.

### Reaction Conditions:

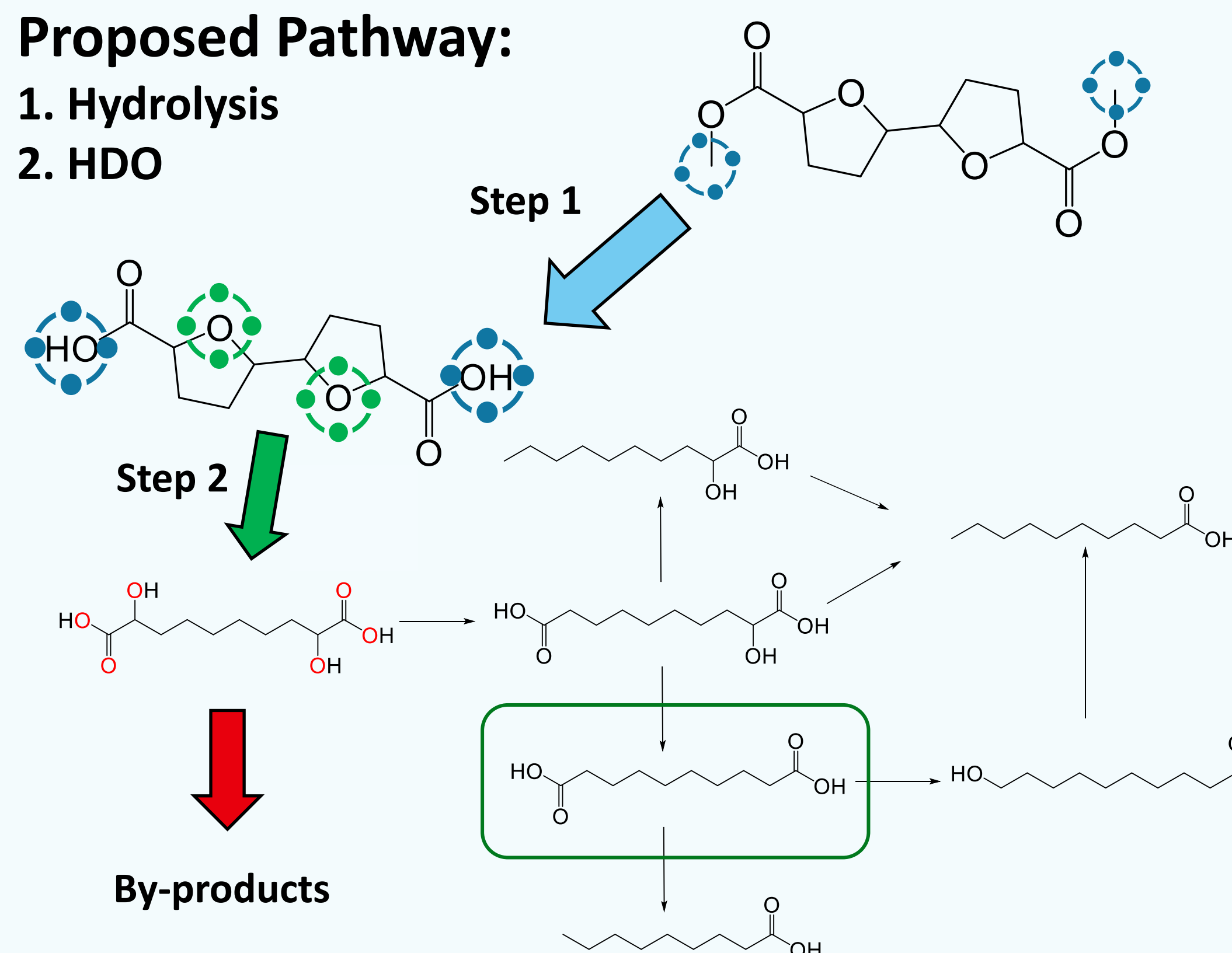
50 mg Catalyst, 2 hours, 3 MPa H<sub>2</sub> initial pressure, 1 mL THF



## Hydrodeoxygenation Activity

### Proposed Pathway:

- Hydrolysis
- HDO

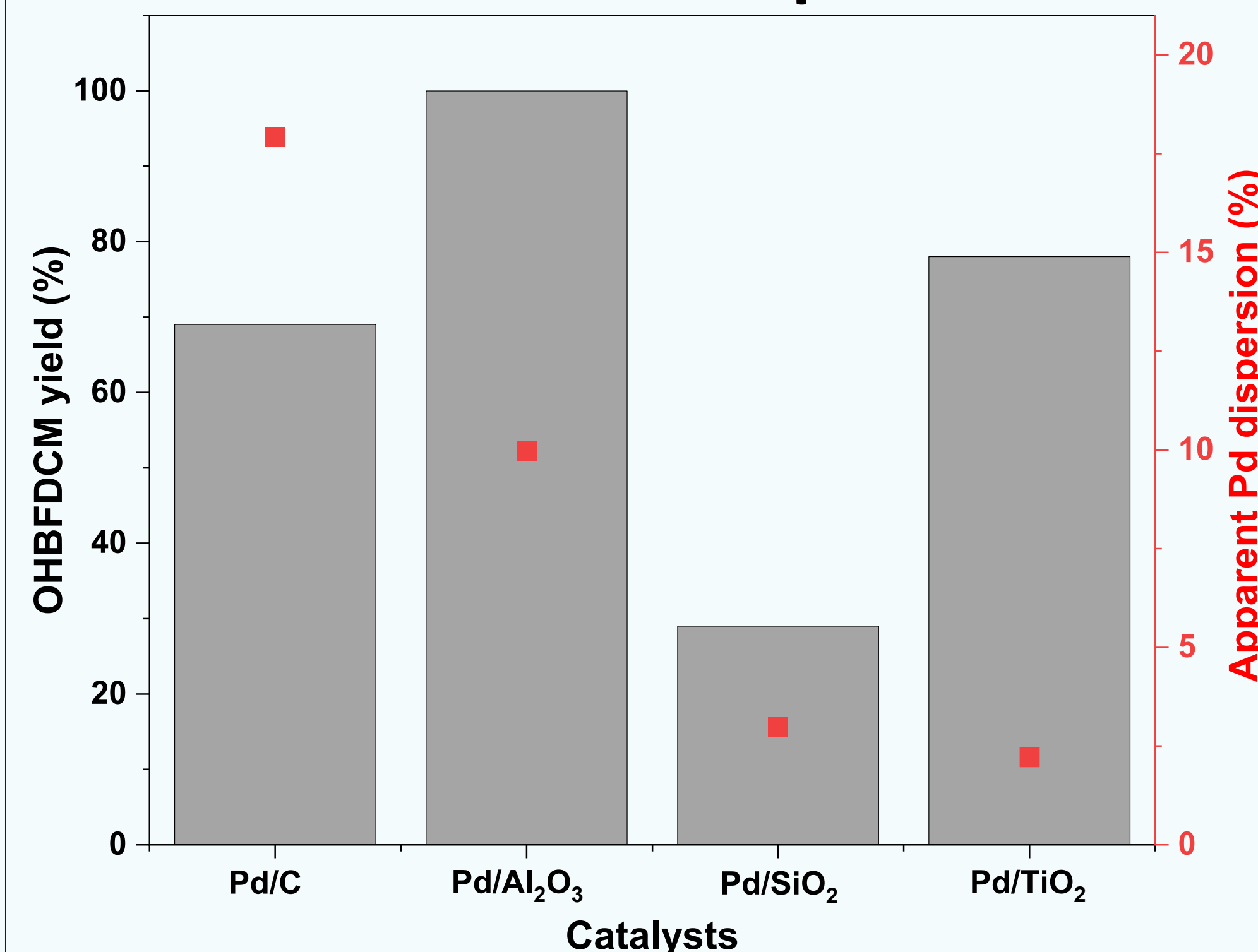


### Activity Test:

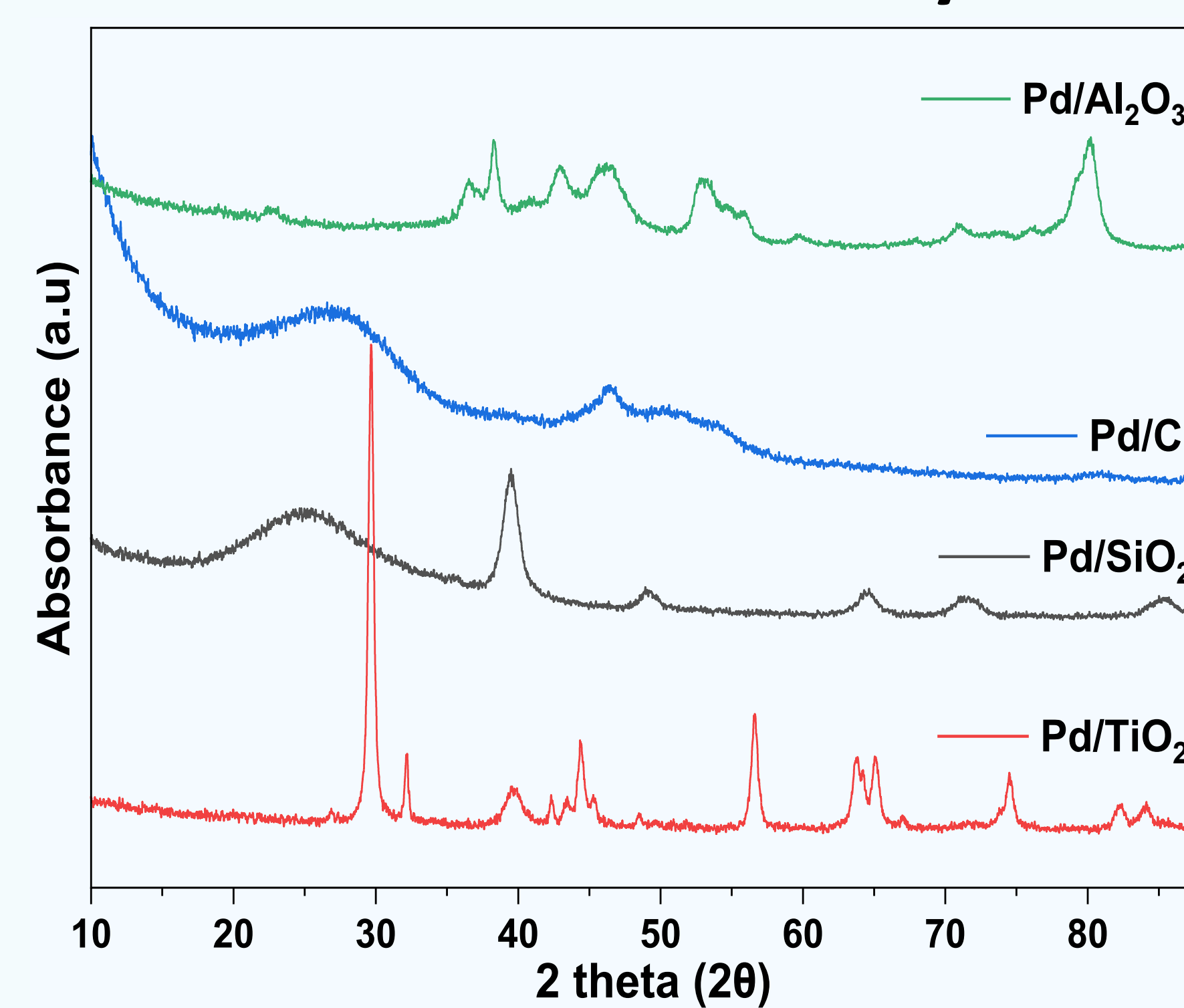
- 50 mg Pt-MoO<sub>x</sub>/TiO<sub>2</sub>, 4 hours hold 220°C, stirring in 0.5 ml water, 350 psi H<sub>2</sub> initial pressure
- Approximately 72% conversion was achieved with 4% selectivity toward Sebacic acid by area
- Longer reaction time matching prior work (24 hours) may increase SA yield toward previously achieved results (37%)

## Catalyst Characterization

### Noble Metal Dispersion

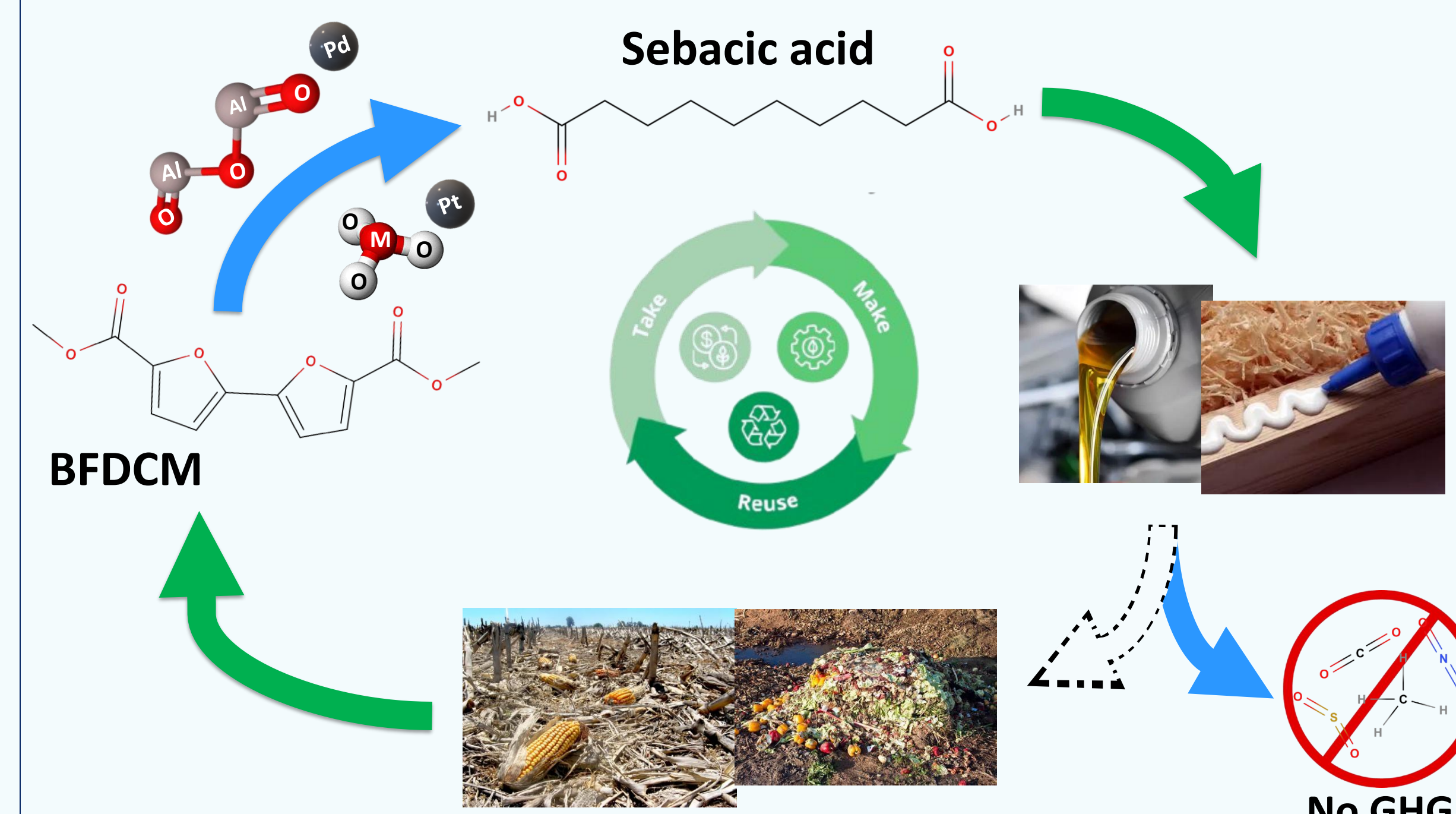


### Phase Confirmation by XRD



## Results

- Pd/Al<sub>2</sub>O<sub>3</sub> at 60°C over 2 hours catalyzed 100% hydrogenated product yield from BFDCM



- HDO produced Sebacic acid in 4 hours, validating this production pathway

## Conclusions & Future Work

- Validation of concept to produce SA from bifuranic molecules with novel hydrogenation yields, meanwhile HDO optimization requires more development
- Further catalyst characterization and HDO optimization will facilitate higher yields and potentially commercialize Sebacic Acid production from biomass
- Incorporation of 2-step findings with BFDCM as a precursors may result in higher SA yields (>37%)

## Acknowledgements

Many thanks to Dr. Allgeier, Samir Castilla-Acevedo, and the University of Kansas Chemical and Petroleum Engineering and EARTH Departments

I am very grateful for the NSF sponsoring this IDEA REU site and enabling environmentally applied research



## References

[1] Mitsubishi Chemical Corp, Bi-tetrahydrofuran Dicarboxylic acid compound and method for producing the same, Japanese Patent JP,2023-117830,A