



# Functional Barrier Materials

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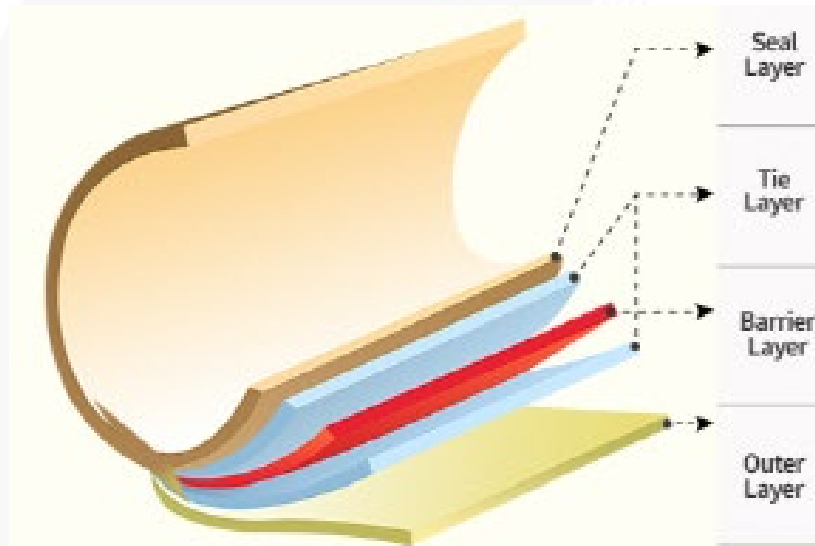
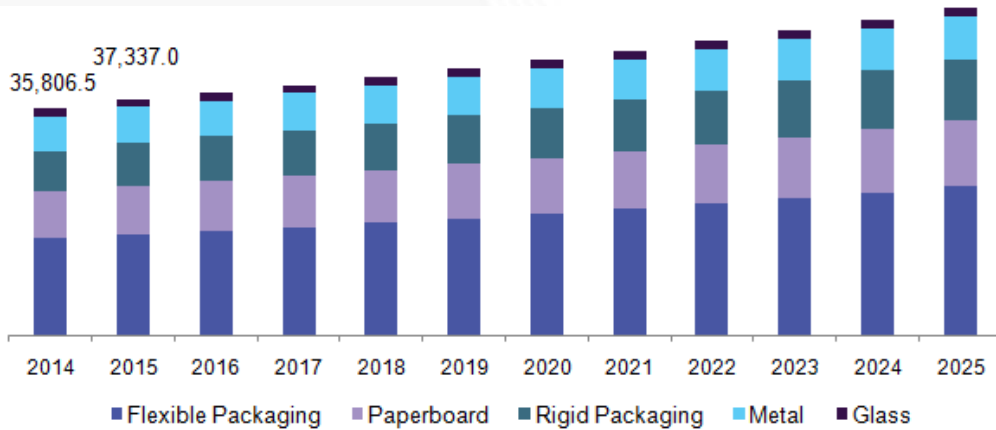


Renewable Bioproducts  
Institute

The logo for the Renewable Bioproducts Institute is positioned at the bottom of the slide. It consists of a photograph of a lush green landscape with various plants and trees. The text "Renewable Bioproducts Institute" is overlaid in white, bold, sans-serif font on the left side of the image.

# Functional Barriers

## Materials critical to food safety



One of the main contributors to waste accumulation

End-of-life by design

Difficulty in mass concentration through recollection

Inherently difficult to deconstruct

## Three Challenge Technologies

**Bio-derived Functional Barriers:** make layers from bioplastics that are inherently biodegradable, enzymatically or chemically reversible

**challenge:** barrier (O<sub>2</sub>/Water) functionality

**Reversible Interfaces:** chemical or physical approaches to triggered reversal of multilayer adhesion

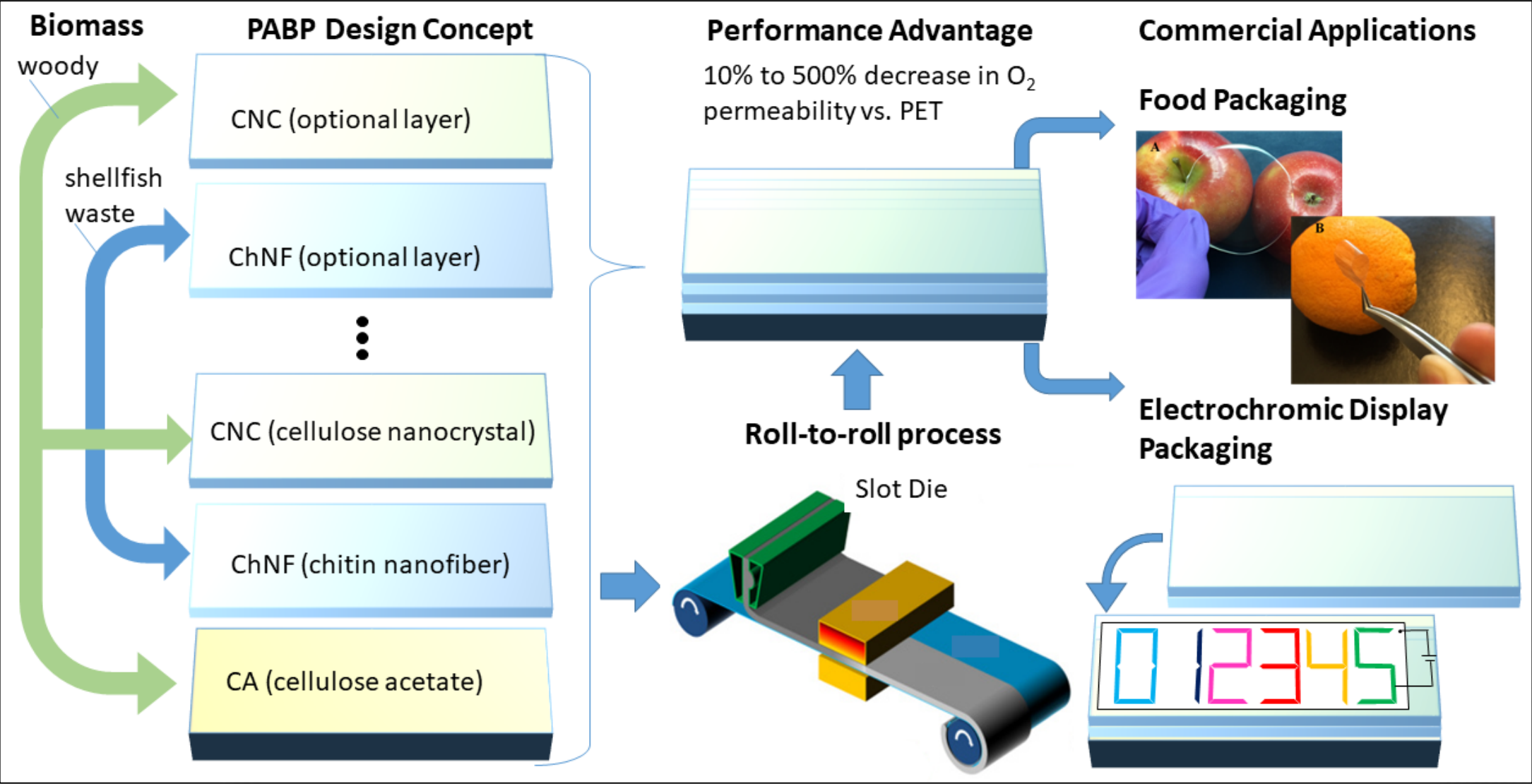
**challenge:** buried interfaces

**Multimaterial depolymerization:** catalysis/separations for multimaterial solids

**challenge:** mechanochemistry and integrated separations

# Bioderived Functional Barriers

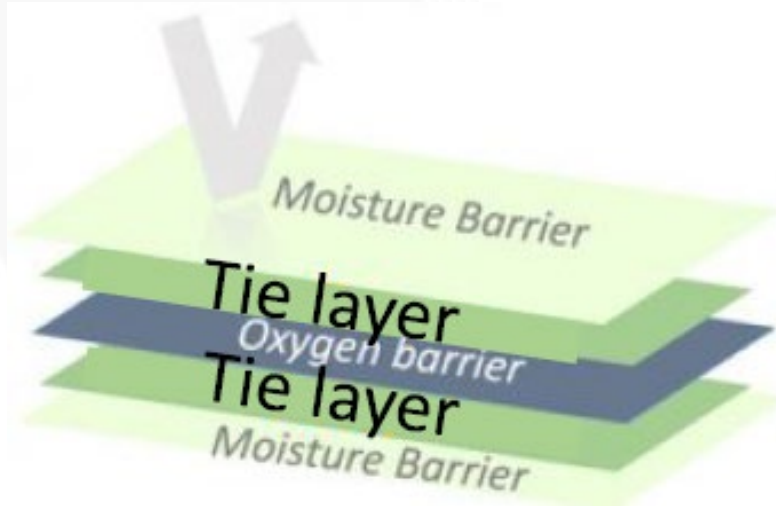
bioplastics with barrier (O<sub>2</sub>/Water) functionality



C. Meredith  
M. Shofner  
T. Harris  
J. Reynolds

# Reversible Interfaces

triggered reversal of multilayer adhesion



## Current Technology

- Irreversible adhesion
- Melt lamination
- Chemically-bonded tie layers

Natalie Stingelin  
Kyriaki Kalaitzidou  
Carson Meredith  
*Georgia Tech*  
*ChBE, MSE*

## Proposed Technology

Chemical or physical motifs with triggerable reversible adhesion

triggers: chemical, light, mechanics, thermal

**Challenge:** wetting, transport, kinetics in buried interfaces

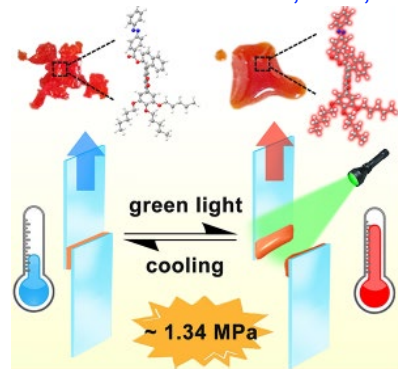


## Layer Separation



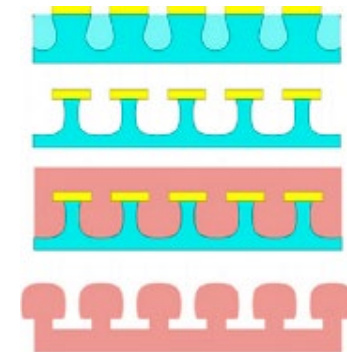
## Green light-reversible azobenzenes

*J. Am. Chem. Soc.* 2019, 141, 7385–7390



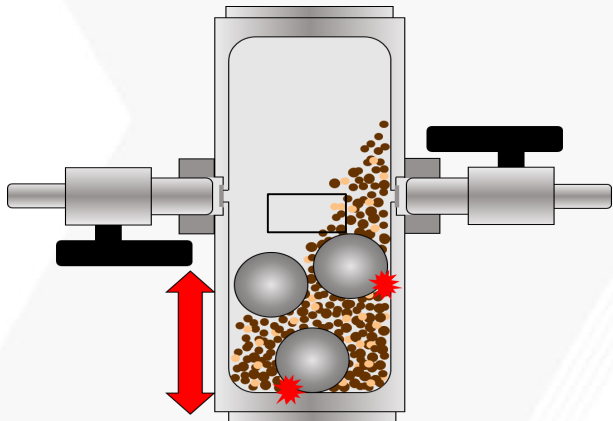
## Biomimetic Physical Patterns

*J. Micromech. Microeng.* 2010, 20, 115037



# Multimaterial Mechanochemical Depolymerization

- Mechanochemical reactions are driven by mechanical impact instead of thermal energy.
- Intimate contact between solids.
- No solvents required.
- Cellulose and lignin have been depolymerized mechano- catalytically.



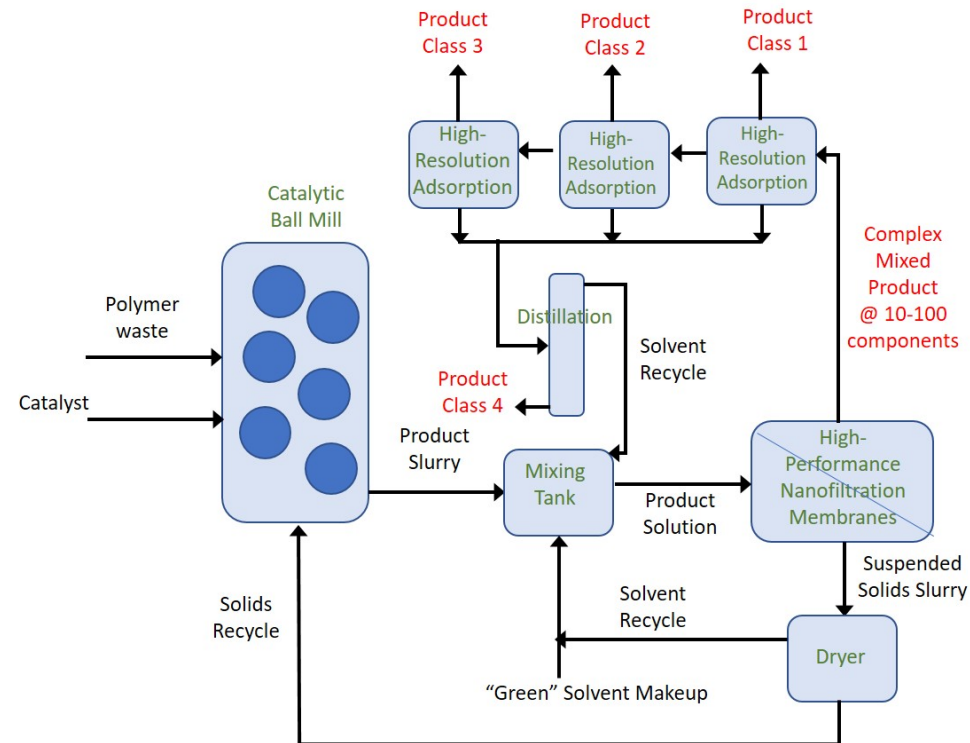
Carsten Sievers  
Georgia Tech  
ChBE

- Application to metallized plastic?  
Lewis-acid (aluminum oxide)  
depolymerization of PET?

[A.D. Brittain et al., Catal. Today 302 \(2018\) 180.](#)

[Tricker et al., Chem. Eng. J. \(2020\) 122954.](#)

- **Integrated processes** combining a network of intensified reactors and advanced separations that enable each other
- Traditional “upstream-downstream” paradigm needs to change
- A key scientific and economic issue in chemical polymer recycling/upcycling: how to accomplish fractionation of depolymerized “crude” without heat-driven separations ?
- Complex multicomponent stream (maybe >100 components)
- Fractionation by class: how to manipulate fractionation to funnel the “crude” into different streams for upgrading ?
- Adsorbent and membrane materials, devices, processes



Sankar Nair  
Fani Boukouvala  
Chris Jones  
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