Sustainable Food Packaging Development Efforts at PepsiCo

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Key Points for Presentation

- Why do we need Sustainable Packaging?
- What is our strategy?
- How are we achieving our goals?

Why do we need Sustainable Packaging?



Why do we need Sustainable Packaging?





Right to Practice

- ❖ Recent legislation in India, UK, ANZ

Lower EPR (Extended producer responsibility)

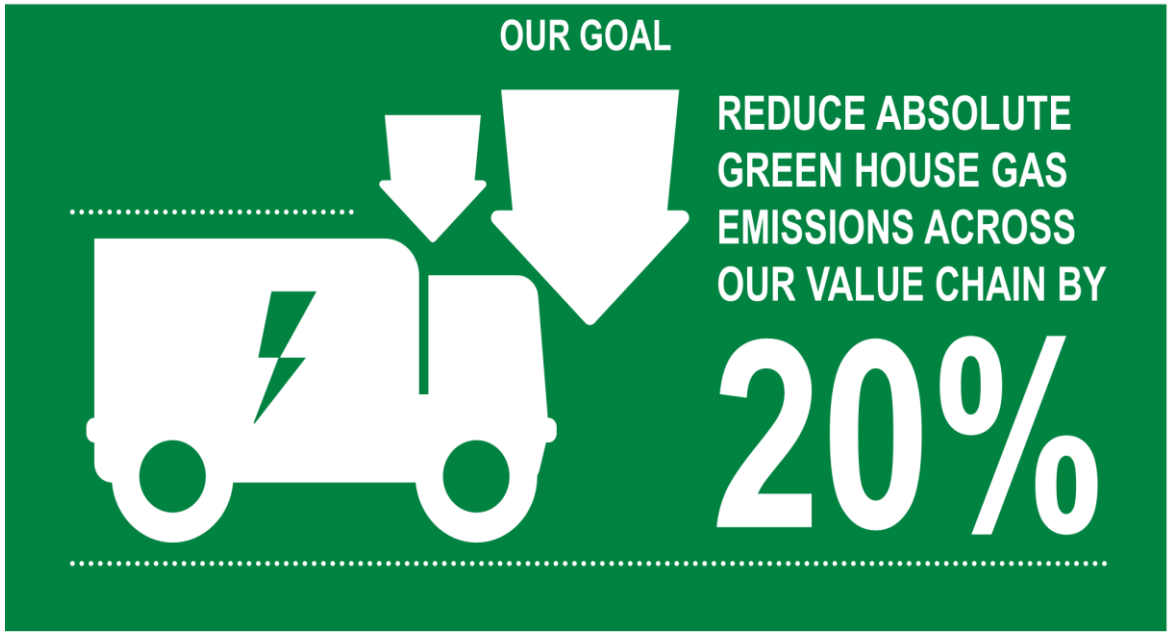
- ❖ Heavy penalties in Europe, Canada

Performance with Purpose

- ❖ Reduction of GHG emissions by 20% from 2014 baseline

As part of PWP 2.0 PepsiCo announced new Packaging Goals



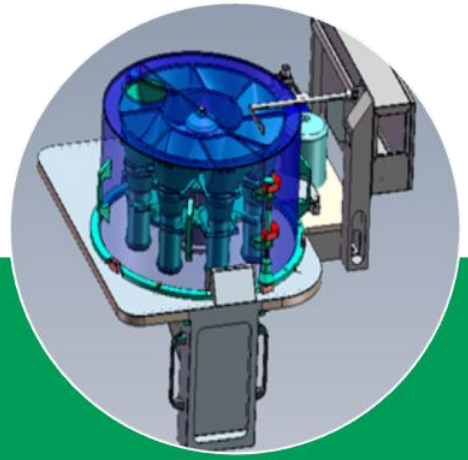


Total Packaging is 28% of Total Scope 3 Baseline

What is our Strategy?



Global Foods Packaging strategy to reduce GHG footprint







SHIP LESS AIR

REDUCED GHG FOOTPRINT

IMPROVE POST-CONSUMER RECOVERY

20% GHG-CO_{2eq}

100% Recyclable/Recoverable Design

Flexible Packaging Sustainability Research Planks

Sustainable Packaging Solutions (Materials)

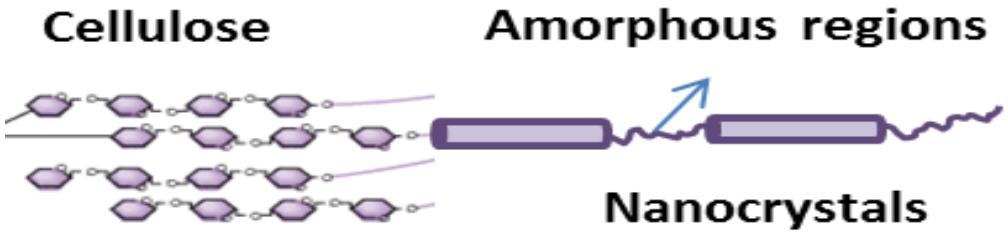


Biofillers



Biopolymers

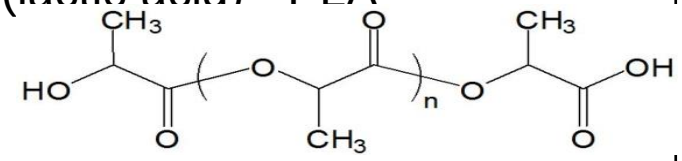
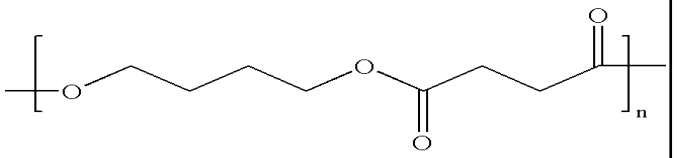
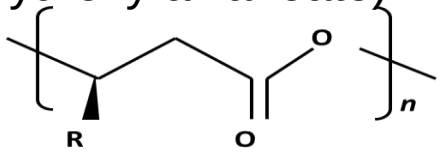




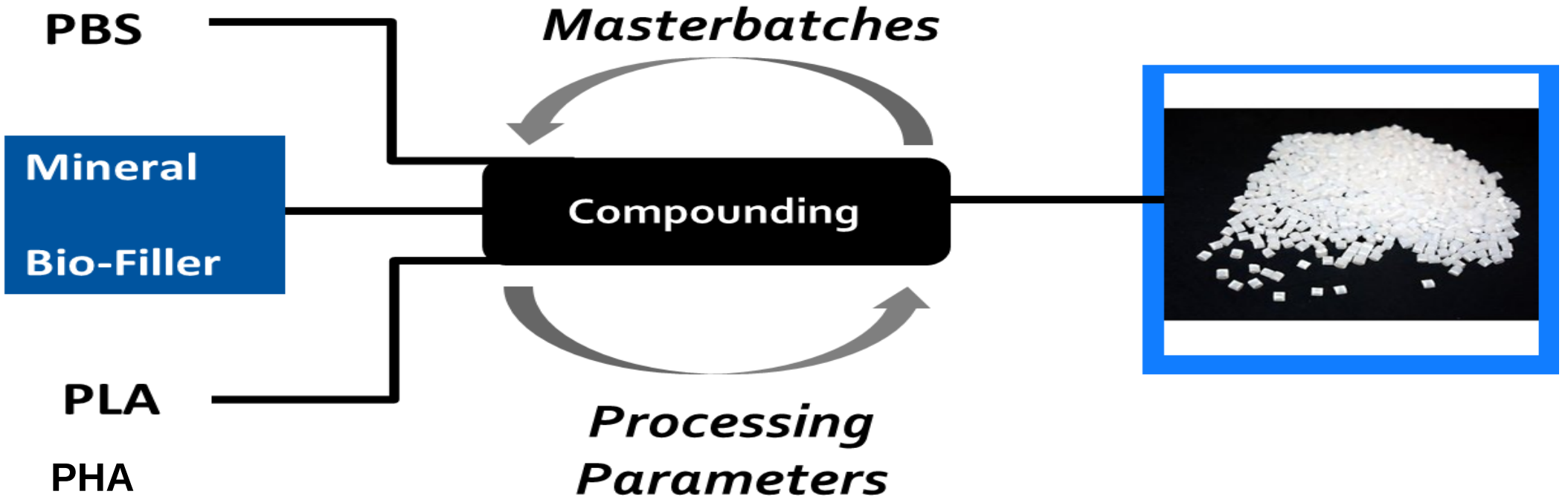
How are we achieving our goals?



Sample Biopolymers

Poly(lactic acid) - PLA 	• Bio-based • Expensive processing • Large volumes • $	Industrial Compostability
Poly(butylene succinate) - PBS 	• Partially bio-based • Polyolefin-like flexibility • Easy processing • Increasing capacity • $$$	Industrial Compostability
Poly(hydroxy alkanoate) - PHA 	• Bio-based • Bio-reactor fermentation of canola oil with microorganisms • $$	**Home Compostability** **Marine degradability**

Adding Filler to the Mix



Cost near par with current materials

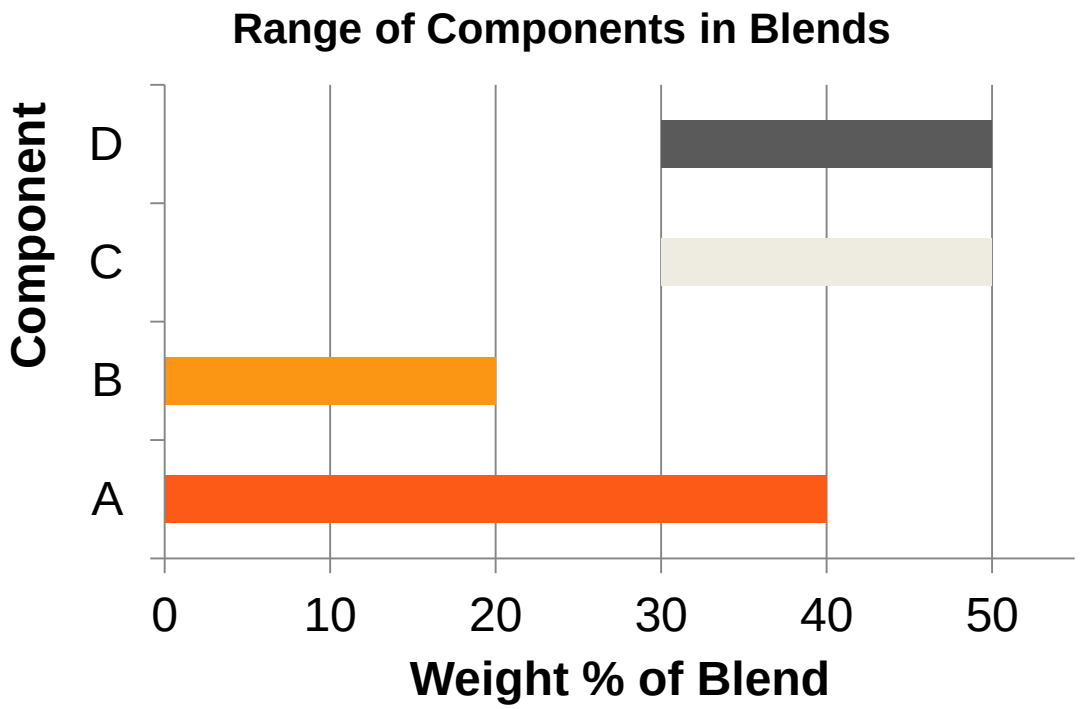
Materials Development – Research Approach

Systematic approach to identify blends which balance sustainability, performance, compostability and cost.

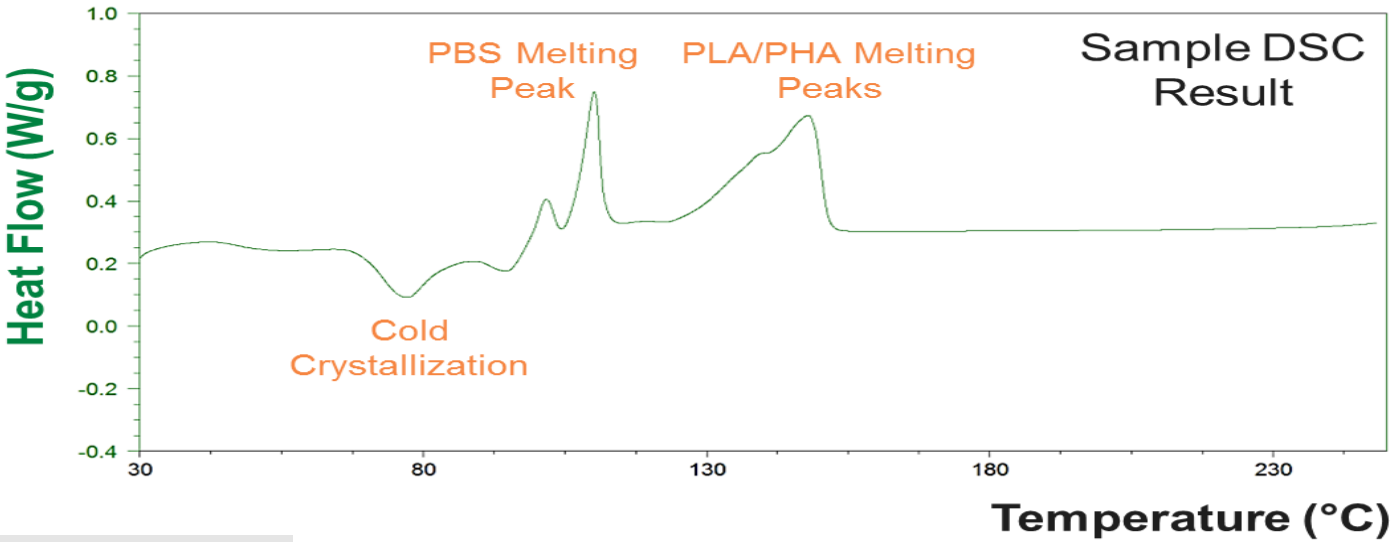
- Compound materials and create baseline characterizations of blends' material properties
- Develop a material-property optimized model
- Develop and incorporate a cost model
- Use a results-driven approach to identify blends which balance performance and cost

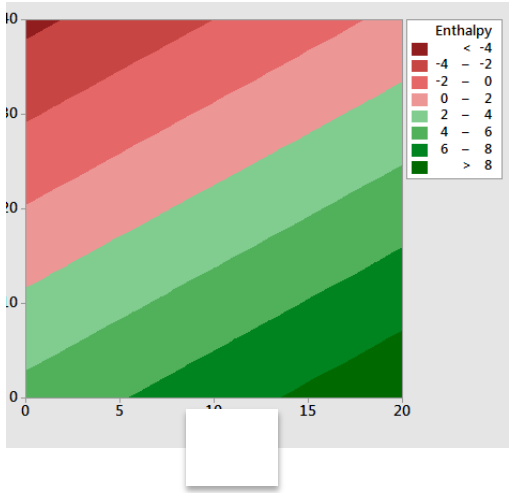
Design of Experiment

- Factors
  - Four component blend
  - Identified 15 blends to characterize
    - 15 blends x 2 replications = 30 batches
- Responses
  - Material properties
    - Thermal
    - Rheological
  - Compostability
  - Cost



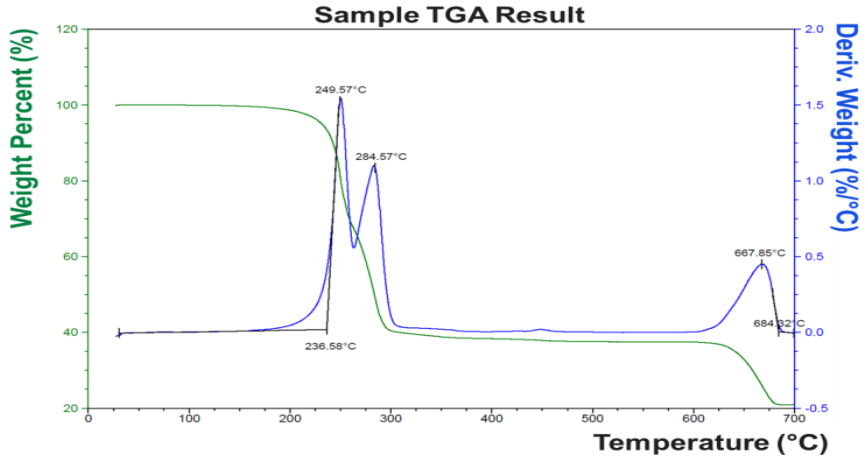
Thermal Study (DSC & TGA) Results



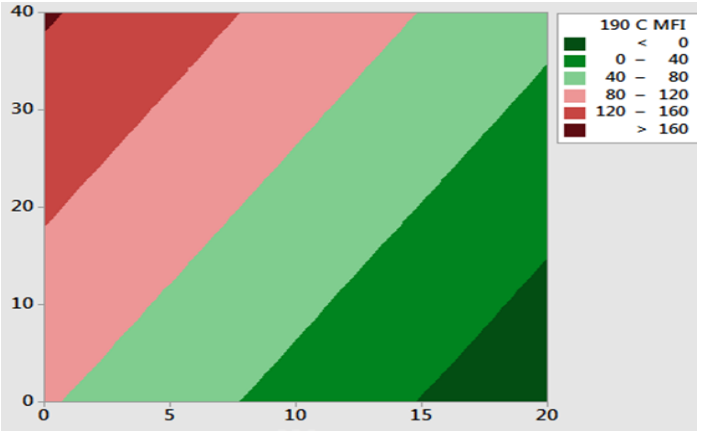


Material Trends

- B increases crystallinity
- A decreases crystallinity
- C,D have a minimal effect on crystallinity



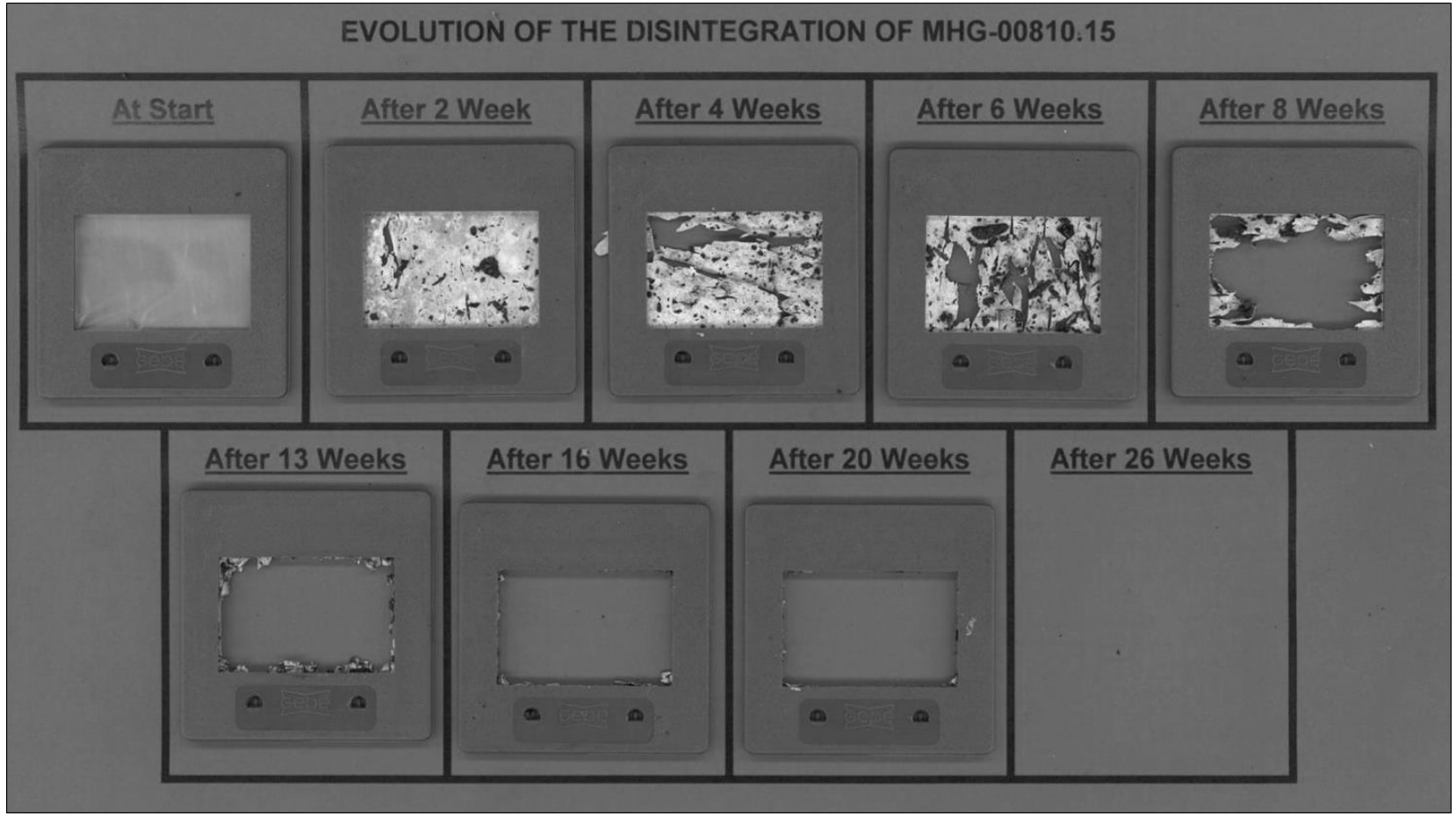
Rheological Characterization Learnings



Baseline characterization of melt properties for all DOE blends

- Minitab regression analysis
- Notable trends:
  - C and D behave similarly
    - Increase of component causes slight increase in MI
  - Tradeoff between A and B

Compostability testing



OPTIMAL BLEND IDENTIFIED FOR FILM CONVERSION

Final Package -Materials & Engineering Solutions

Bio-based Barrier Web



Compound



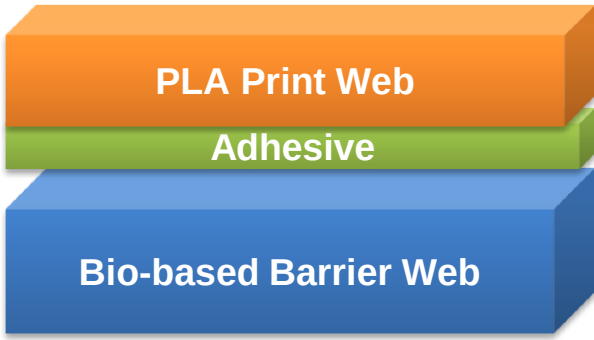
Extrusion



Coat & Metalize



Adhesive Lamination



- Identifying primer coating and adhesive
- Operational optimization to run materials on existing asset
- Conversion optimization to maximize performance

Cost-effective commercially feasible solution

Bio-based Fillers



Bio-based Fillers









- Particle size reduction
  - 10 microns or less
- Compatibilization
  - Identification of compatibilizer
  - Highly filled master blends
- Processing into films
- Color and odor control

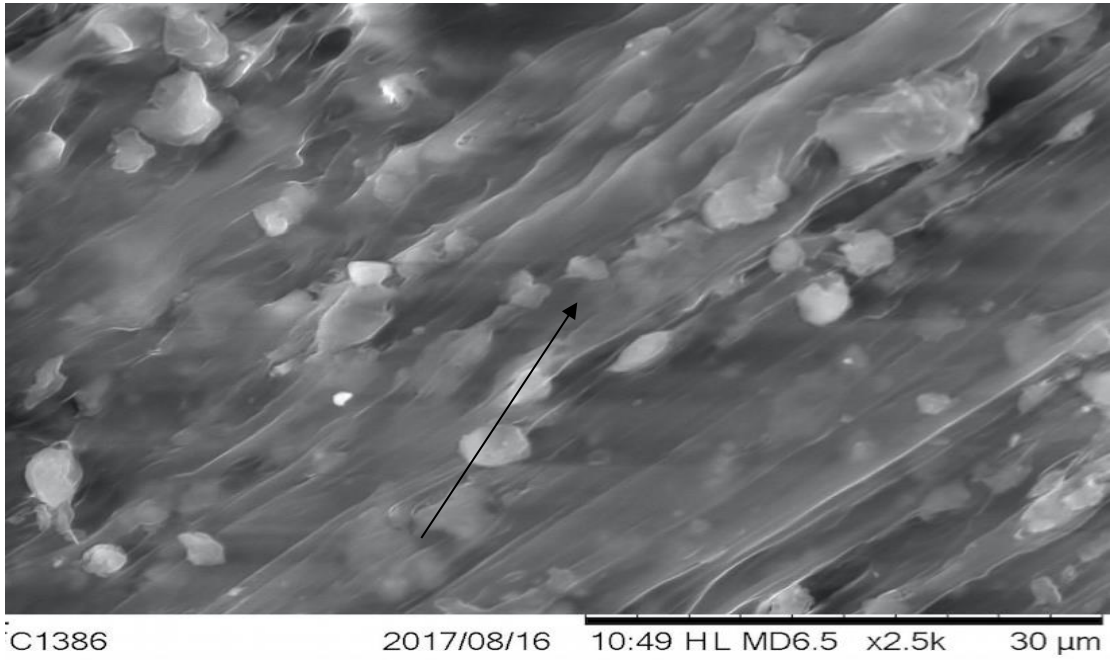
Compounding with Polymers



- Compounding in typical twin screw extruders followed by pelletization
- Oat hulls loading should depend on choice of polymers, compatibilizers, processing parameters

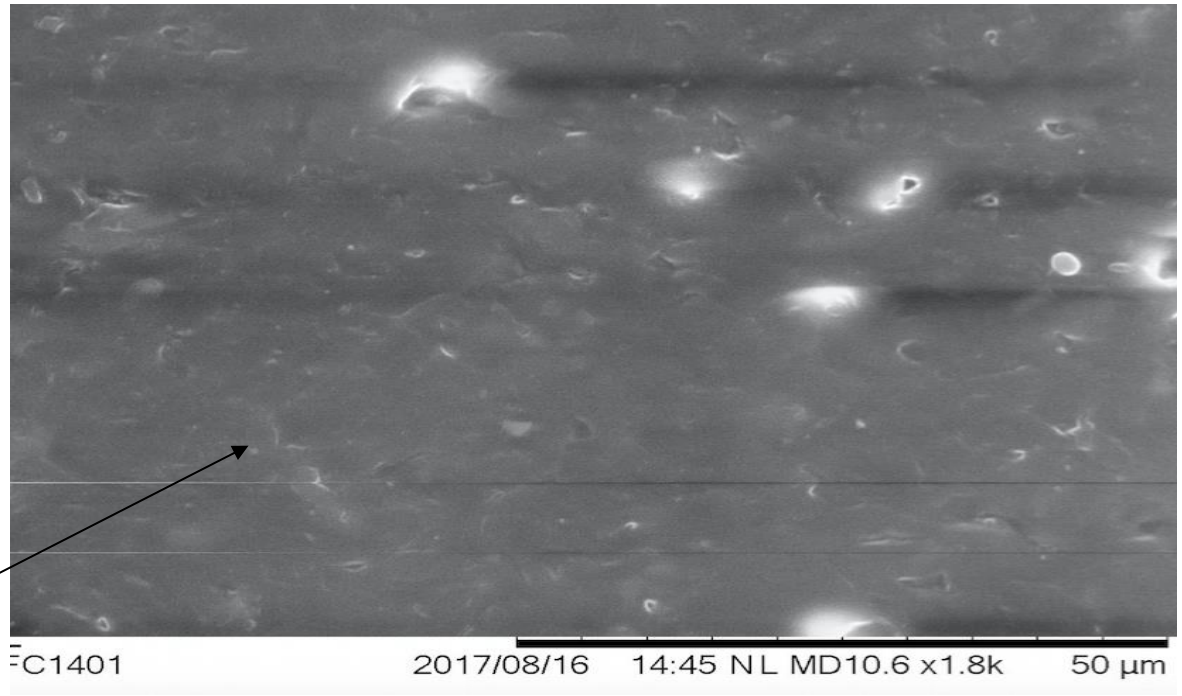
SEM Results of Oat Hulls Dispersion

Cross-section image of 40 wt% oat hull film



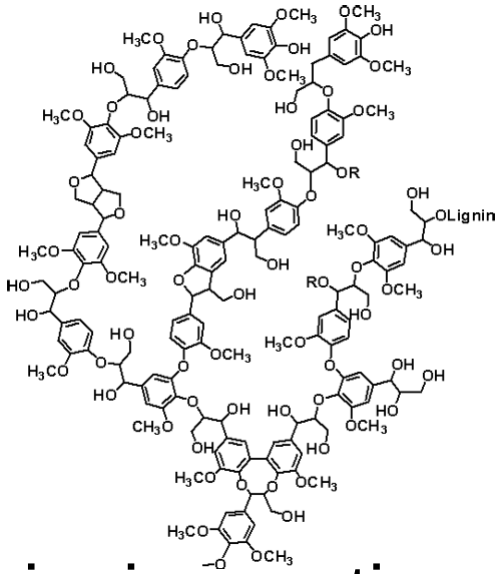
- Oat hull well dispersed and well-wetted with PP matrix
- No agglomeration observed

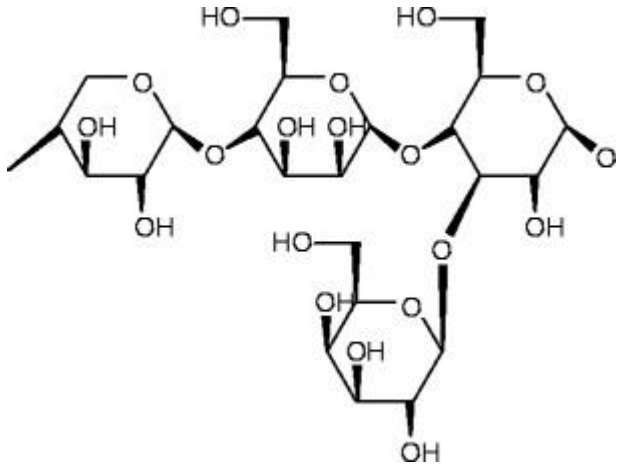
Surface image of 40 wt% oat hull film

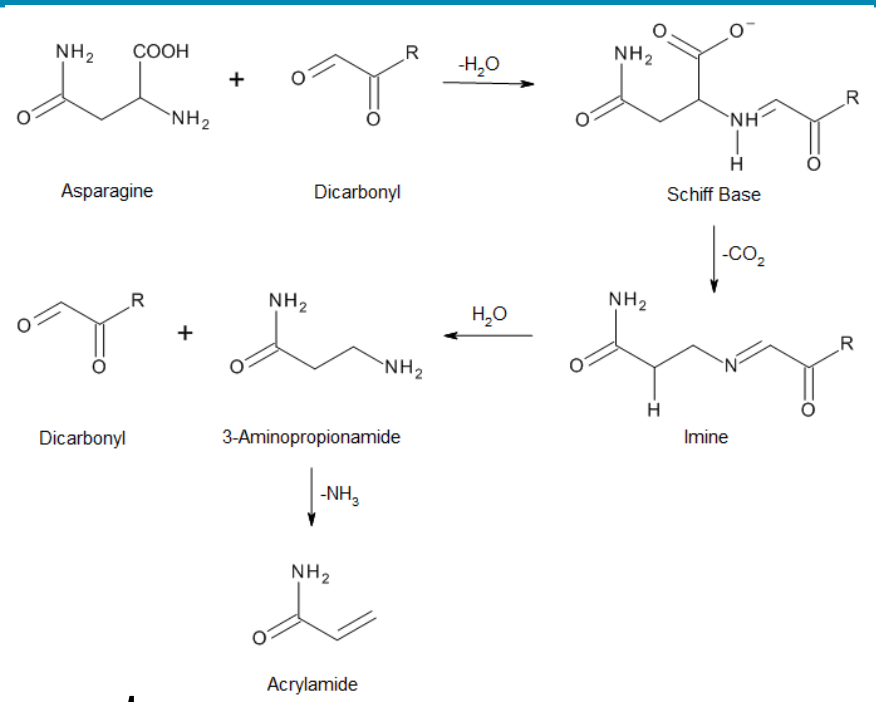


- Little to no presence of oat hulls on surface
- Very smooth

Hypothesis around color and Odor



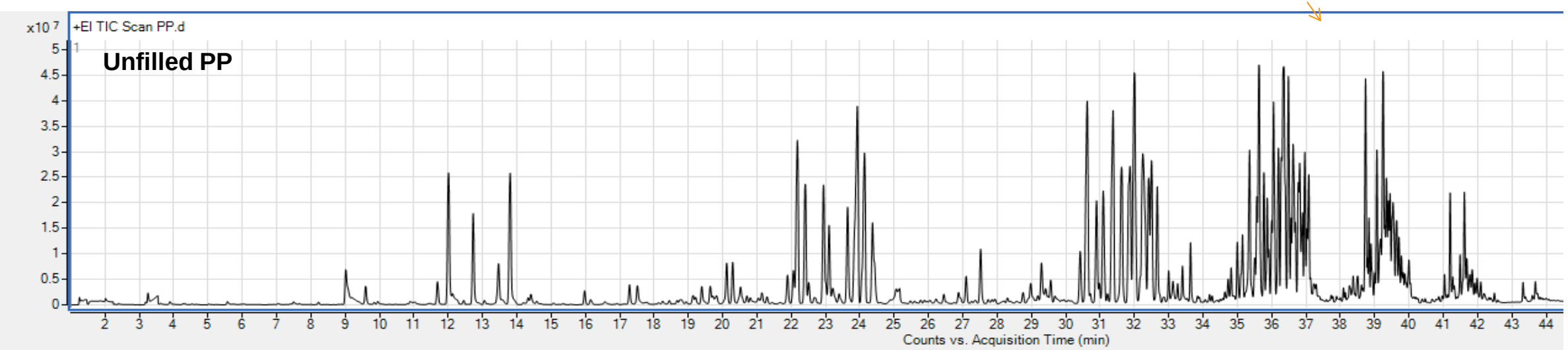


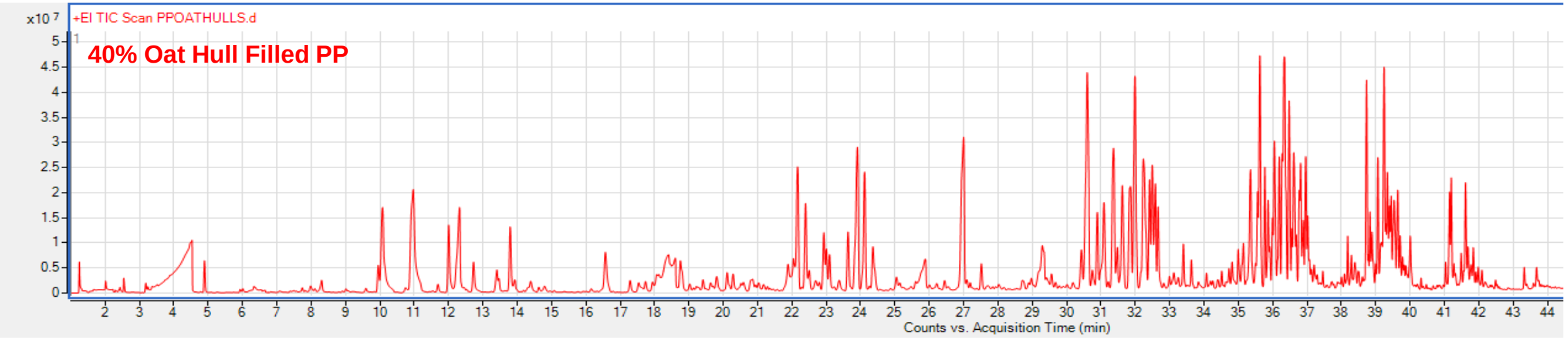


- Lignin reactions at high temperature
- Degradation of hemi-cellulose at high temperatures
- Maillard reactions between reducing sugars and protein in the fillers at high temperatures.

Samples collected for Volatile Analysis to confirm Mechanism

Volatile Flavor Compound Differences





Odor Analysis Summary

- The key sensory aroma differences were sweet and burnt notes found in the 40% oat hull filled polypropylene (PP)
- The sweet and burnt notes were mainly from the sugar degradation (furan derivatives). Oat Hull has significant sources of sugars
- Maillard Reaction Compounds (MRPs) also contribute potential odor to the packaging
- Lipid oxidation compounds and acids add odor to a small extent

Progress made in addressing Challenges

- Particle size reduction 
  - 10 microns or less (For film applications)
- Prevention of Particle Agglomeration 
- Compatibilization
  - Identification of compatibilizers 
  - Highly filled master blends 
- Processing into films, sheets 
- Color and odor control (important for food packaging applications) 

Summary – Sustainable Packaging

Holistic materials science approach

Research Area 1: Green- house gas reduction

- Strategic multi-pronged approach
  - Bio-based Polymers
  - Bio-based fillers
  - Nano-crystalline Materials
  - Tools to enable sustainable packaging design

Research Area 2: End of life options for Flexible packaging

  - Industrial Compostable packaging
  - Home compostable packaging
  - Recycling, Upcycling options