PHA Polymer Prototypes
Dr. Laura Morales

- Films for packaging applications
- Adhesives
Processing conditions are crucial.
- Temperature-DSC Melting
- Thermal Degradation temperature TGA

Blend Preparation
Temperature, Time, Speed, 40cc$^3$
Mechanical properties evaluation

Hydraulic press

Bioplastic Technologies
Biodegradable Polymers
Mechanical properties evaluation

Hydraulic press
Mechanical properties evaluation

Hydraulic press

Modulus
Mechanical properties evaluation

Hydraulic press
Mechanical properties evaluation

- **Modulus**
- **Strength & Strain at break**
- **Toughness**

*Hydraulic press*
Biobased Polymer blends - PLA/PHB optimized blends

<table>
<thead>
<tr>
<th></th>
<th>Biobased content (%)</th>
<th>Petro based content (%)</th>
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<tbody>
<tr>
<td>PLA+mclPHA</td>
<td>100</td>
<td>0</td>
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<tr>
<td>Bioplastech1 (1432)</td>
<td>100</td>
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<td>Bioplastech2 (1433)</td>
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<td>Bioplastech3 (1434)</td>
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<td>Bioplastech4 (1435)</td>
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<td>Bioplastech5 (1436)</td>
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<td>PLAPBAT©</td>
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<tr>
<td>PLAPBAT© (Bioflex)</td>
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Bio based - 100-85%

Graph showing elastic modulus and ultimate tensile strength for different blends.
Scale up - Pellet preparation

Leistritz twin screw extruder - a ZSE 27 MAXX – 40 L/D Pelletizer

IPC-Ireland
Film Casting
PLA + mclPHA, Bioplastech R, and Bioplastech M

<table>
<thead>
<tr>
<th>SAMPLE</th>
<th>Bioplastech mcl-PHA</th>
<th>Temp. (C)</th>
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<tbody>
<tr>
<td>411 PLA</td>
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<td>200</td>
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<td>412 PLA-mclPHA</td>
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<td>190</td>
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<td>412 PLA-mclPHA</td>
<td>R</td>
<td>200</td>
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<tr>
<td>413 PLA-mclPHA</td>
<td>M</td>
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<tr>
<td>413 PLA-mclPHA</td>
<td>M</td>
<td>220</td>
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Bioplastech PHB Optimized blends

Bioplastech blends = 85% Biobased Commercial 18-32%
Adhesives

- Hot Melt Adhesives (HMA)
- Pressure sensitive adhesives (PSA)

- PHB
- Mcl-PHA

PHB, mcl-PHA formulations

Main Matrix for HMA & PSA

Commercial Samples

- Evaluation of properties (Peel Strength)
- Compare properties with commercial applications
- Complete characterization

<table>
<thead>
<tr>
<th>PROPERTY</th>
<th>Standard Method</th>
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<tr>
<td>Peel Strength</td>
<td>ASTM D3330</td>
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<tr>
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<td>ISO 8510; ISO 11339</td>
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<tr>
<td>Open Time</td>
<td>ASTM D4497</td>
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<tr>
<td>Setting Time</td>
<td>ASTM D6463-99</td>
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<td>Heat Resistance</td>
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<td>Thermal Stability</td>
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Adhesives, PHB formulations HMA

Formulation Design
- Polymer
- Waxes
- Tackifiers (natural)
- Antioxidants
- Other Additives
  - Detackifiers
  - Plasticisers
  - Compatibilicers

Substrate
PET
# HMA, mcl-PHA

<table>
<thead>
<tr>
<th>Sample</th>
<th>Polymer</th>
<th>Bio-based content</th>
<th>Peel Strength (N)</th>
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<tr>
<td>G46</td>
<td>M</td>
<td>97</td>
<td>8.45</td>
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<td>G60</td>
<td>T12</td>
<td>100</td>
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<tr>
<td>G64</td>
<td>T12</td>
<td>80</td>
<td>8.44</td>
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</tbody>
</table>

**Applications:**
- Assemble disposable containers
- Boxes
- Paper – paper bags
- Paper-cellulose windows
- Paper-PLA windows

![Graph showing peel strength (N) for different samples](image)

**Commercial adhesive:**
- (SIS)
- (EVA)

**Bioplastech T12**

**Applications:**
- 100° - 120°C
PSA- mcl-PHA

- Solvent borne processing
  - Coating
  - Drying
  - Curing (chemically, radiation)

Labels – Cellulose based film coated
PSA- mcl-PHA  Cold temperatures
HMA-PSA -- Hot melt coater
Thank you!