SUSTAINABLE PLASTIC PACKAGING FROM RECYCLED AND RENEWABLE PLASTICS, AND/OR INDUSTRIAL FOOD WASTE

Michael R. Snowdon, Amar K. Mohanty, Manju Misra

Bioproducts Discovery and Development Centre
University of Guelph
Ontario, Canada
Key points: What I will be presenting?

• Circular Economy? “Waste-free” World – Linear model vs. Closed-loop System

• Research & Innovation to supplement “Circular Economy” – Focus on Biobased Materials
  – (I) Compostable Packaging & Consumer Products
  – (II) Durable Auto-parts

• SUSTAINABLE MATERIALS? From Bio-sourced, recycled materials, waste resources & their Various Combinations

• Concluding thoughts
As resources dwindle and waste piles up

- **World population** - to reach 8.6 billion in 2030, 9.8 billion in 2050 and surpass 11.2 billion in 2100.

- **Plastic pollution** including littered single used utensils, bottles, bags and food packaging that end up in world’s rivers and oceans.

- According to the UN, **during every minute, a dump truck of plastic waste is pouring into the sea**: By 2050, there will be **more plastic** in the ocean than fish.

The rise of plastics

This chart shows just how sharply plastic use has risen since 1950, leaving more and more of the material in the world's ecosystems each year.

448 million tons
Produced in 2015

Legacy of World War II
Shortage of natural materials during the war led to a search for synthetic alternatives-and an exponential surge in plastic production that continues today.

A Lifetime of Plastic

1973 Oil crisis

2008 recession


PLASTICS AND U.S. RECYCLING RATES

<table>
<thead>
<tr>
<th>Plastic Type</th>
<th>Production</th>
<th>Recycled</th>
<th>Land-filled</th>
</tr>
</thead>
<tbody>
<tr>
<td>High-Density Polyethylene</td>
<td>5.5 BILLION KG</td>
<td>10.3%</td>
<td>89.7%</td>
</tr>
<tr>
<td>Polyethylene Terephthalate</td>
<td>4.5 BILLION KG</td>
<td>19.5%</td>
<td>80.5%</td>
</tr>
<tr>
<td>Polyvinyl Chloride</td>
<td>0.9 BILLION KG</td>
<td>0.0%</td>
<td>99.9%</td>
</tr>
<tr>
<td>Low-Density Polyethylene</td>
<td>7.4 BILLION KG</td>
<td>5.3%</td>
<td>94.7%</td>
</tr>
<tr>
<td>Polypropylene</td>
<td>7.2 BILLION KG</td>
<td>0.6%</td>
<td>99.4%</td>
</tr>
<tr>
<td>Polystyrene</td>
<td>2.2 BILLION KG</td>
<td>0.9%</td>
<td>99.1%</td>
</tr>
<tr>
<td>Other Plastics</td>
<td>DATA UNAVAILABLE</td>
<td>0.0%</td>
<td>100.0%</td>
</tr>
</tbody>
</table>

Reference: C&EN 2018 – Created by Andy Brunning for C&EN
Unsustainable Plastic Packaging: Broken cycle

Eighty-six percent of plastic packaging produced globally is never collected for recycling.

8% is recycled into lower-quality products and just 2% is recycled into equivalent products.

Sources: World Economic Forum; Ellen MacArthur Foundation
Organisation for Economic Co-operation and Development (OECD) Estimate: Bioeconomy will contribute 2.7% of Global GDP by 2030

Complete Sustainability!
-Bioeconomy combines Circular economy

Sustainable Packaging Trends
$274 Billion market by 2020!

Green Packaging: Degradable, reusable or recyclable
Perennial Grass Reinforced Recycled Plastic (PP) based Biocomposites in Market

| Product Status | Biobins (Home Hardware) and Eco-Resin flower pots (Lowes and Kroger) |

“Circular Economy: Value-addition of recycled plastic: 
**Reduce** virgin plastic use

Coloured Storage Bio-bins @ Home hardware

Flowerpot @ LOWES & KROGER
Compostable Coffee Pod Invented @ U of Guelph *

Single-serve coffee: Continues to Grow!
$1Bn - 2014 Cdn sales & $4Bn - 2014 US sales

Eco-Impact: Single-serve Coffee Pods
Sale:
14 billion in 2016
Wrap around the earth 14 times


Mohanty et al; WO 2016/138593 A1
An Example of Circular Economy based Biocomposites – Now in Market Place

US, Canada, South America, Mexico & beyond

PP/PET-based non-compostable

Bioplastic-based biocomposites & compostable
Pyrolyzed Biomass/wastes: Thermo-chemical Conversion

Key challenges: Traditional bio-composites: Injection moulded auto-parts
- Smell/odour issues
- Aesthetic challenge
- Supply chain

Biomass
- Organic wastes
- Bioenergy crops
- Crop residues

Bio-oil

Biochar

Low value soil amender

How?

Biocarbon as reinforcements/fillers
New Biocarbon (BioC)-based Materials: Pioneer in the World: Invented >30 Types of BioC-5 Patents

Control: Mechanical Properties, Modulus, Electrical Conductivity etc.

Auto-parts, Consumer Products, Packaging, Super Capacitor, Battery etc.

3D printing: Big Boom – Sustainable Manufacturing

- Biomedical
- Aerospace
- Automotive

Miscanthus + PLA/ PBS/ PBAT blend
Few Key Messages: Concluding Thoughts

“Circular Economy in packaging and other good and services”: an inevitable transformation and a trillion $ business; disruptive technology; closed loop system, achievable & profitable

- “Nothing is waste – Waste is a Resource for a new Industry”

- Value-added biobased materials from wastes – Food/Agro-food wastes & Plastic Wastes Integration to Products

- Certified compostable products & packaging: reduce landfill

- Circular Economy: Sustainable global growth and development: Zero Waste, Reduced GHG, a better planet
Acknowledgements

- Numerous additional industrial/govt./NGO/University partners
- BDDC, U of G research group (Graduate students, Undergraduates, Post-doctoral Research Associates, Visiting Researchers/Scholars)
Bioproducts Discovery & Development Centre (BDDC) Group
Michael R. Snowdon, MSc, PhD Candidate
Lab Manager and Research Development Specialist
Bioproduct Discovery and Development Center
University of Guelph, Canada
Crop Science Building, University of Guelph; ON, Canada, N1G 1Y4
Tel: (519) 824-4120 ext. 58956
https://www.bioproductscentre.com/