

The PolyOne logo is located in the top left corner, featuring the word "PolyOne" in a red serif font with a white underline, set against a background of green circular swooshes.

*PolyOne*

# Latest Developments in masterbatches for bio-based & biodegradable plastics



**PolyOne  
Sustainable  
Solutions**

Bioplastics Processing & Properties  
Sheffield , 6 october 2011  
Marcel Dartee  
Marcel,dartee@polyone.com

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# About Us: PolyOne Corporation (NYSE: POL)

- A leading, global provider of specialized polymer materials, services and end-to-end business solutions
- 2010 annual revenues of approximately \$2.6 billion
- Headquartered in northeast Ohio, USA
- Operations in North America, South America, Europe, and Asia
- PolyOne serves more than 10,000 customers globally and offers more than 35,000 polymer solutions
- PolyOne has more than 4,000 employees worldwide in:
  - More than 60 manufacturing and distribution facilities
  - Over a dozen labs and technical centers
  - Sales and service locations on four continents





## Facility Locations - Europe

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# Globally Positioned to Serve our Customers



Throughout the world, PolyOne has established a network of manufacturing facilities, sales offices and warehouses to help customers transact business seamlessly in the global economy.

<b>Regional Headquarters</b>	<b>Manufacturing</b>	<b>Sales/Service</b>	<b>Warehouse</b>	<b>Manufacturing Sales/Service</b>	<b>Warehouse and Sales/Service</b>
					



# Facility Locations - Europe



**Colors & Additives :**  
color & additive concentrates



**Engineered Materials :**  
reinforced and filled polymer  
compounds (PA, PBT, PET, POM etc.)  
and thermoplastic elastomer compounds



**LSFOH :**  
flame retardant, halogen-free compounds

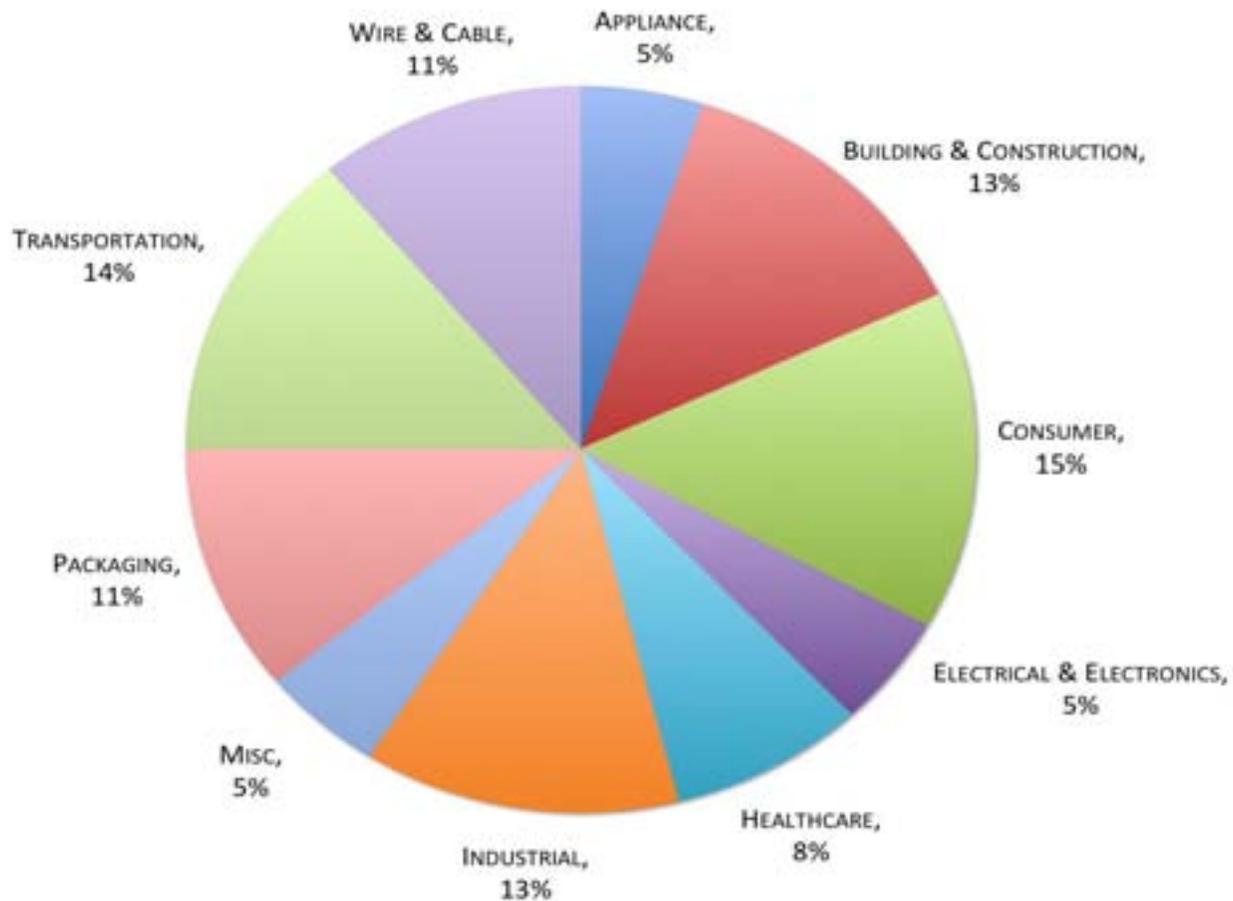




# Industries Served

## 2010 Sales by Industry

(% of global revenues by industry segment)





# Products / Services Overview



**Color and Additives**



**Specialty Inks and Polymer Systems**



**Engineered Materials**



**NEU Specialty Materials**



**GLS Thermoplastic Elastomers**



**ECCOH High Performance Solutions**



**Geon Performance Materials**



**Specialty Coatings**



**Specialty Resins**



**Producer Services**



**PolyOne Distribution**



**Polymer Diagnostics**





# PolyOne Sustainable Solutions

PolyOne has established the “**PolyOne Sustainable Solutions**” certification to denote those products or services that meet defined standards for sustainability in areas such as renew-ability, recycle-ability, reusability, eco-conscious composition, or resource efficiency

- ⇒ **Renewable:** Solutions that are based on, or support the use of, renewable, compostable or bio-degradable resources
- ⇒ **Reusable:** Packaging and other logistics-related systems which are easily returned or reused
- ⇒ **Recyclable:** Solutions which incorporate post-consumer or post-industrial recycle content or which lend themselves to recycling such as PlanetPak™ packaging system
- ⇒ **Eco-conscious Composition:** Solutions that respond to ever-changing market needs by offering alternatives to traditional chemistries such as lead, bisphenol-A (BPA), phthalates, or halogens
- ⇒ **Resource Efficient:** Solutions that help conserve the earth’s resources such as those that enable more efficient production, reduce part weight or material consumption, enable faster cycle times or lower energy consumption



**PolyOne  
Sustainable  
Solutions**



# Biomaterial scope

## ⇒ **Bio-degradable / Compostable Polymers**

- ⇒ Consumed by microbes producing only carbon dioxide, water, and residual biomass
- ⇒ Can be from agricultural resources OR petrochemical resources

## ⇒ **Bio-based or Bio-derived Polymers**

- ⇒ Derived from agricultural/renewable resources
- ⇒ Might be compostable / biodegradable but do not need to be

## ⇒ **Bio-polymer Additives**

- ⇒ May or may not be bio-based and/or biodegradable
- ⇒ Functional additives specific for biomaterials
  - ✓ Help biopolymers with processing and / or performance

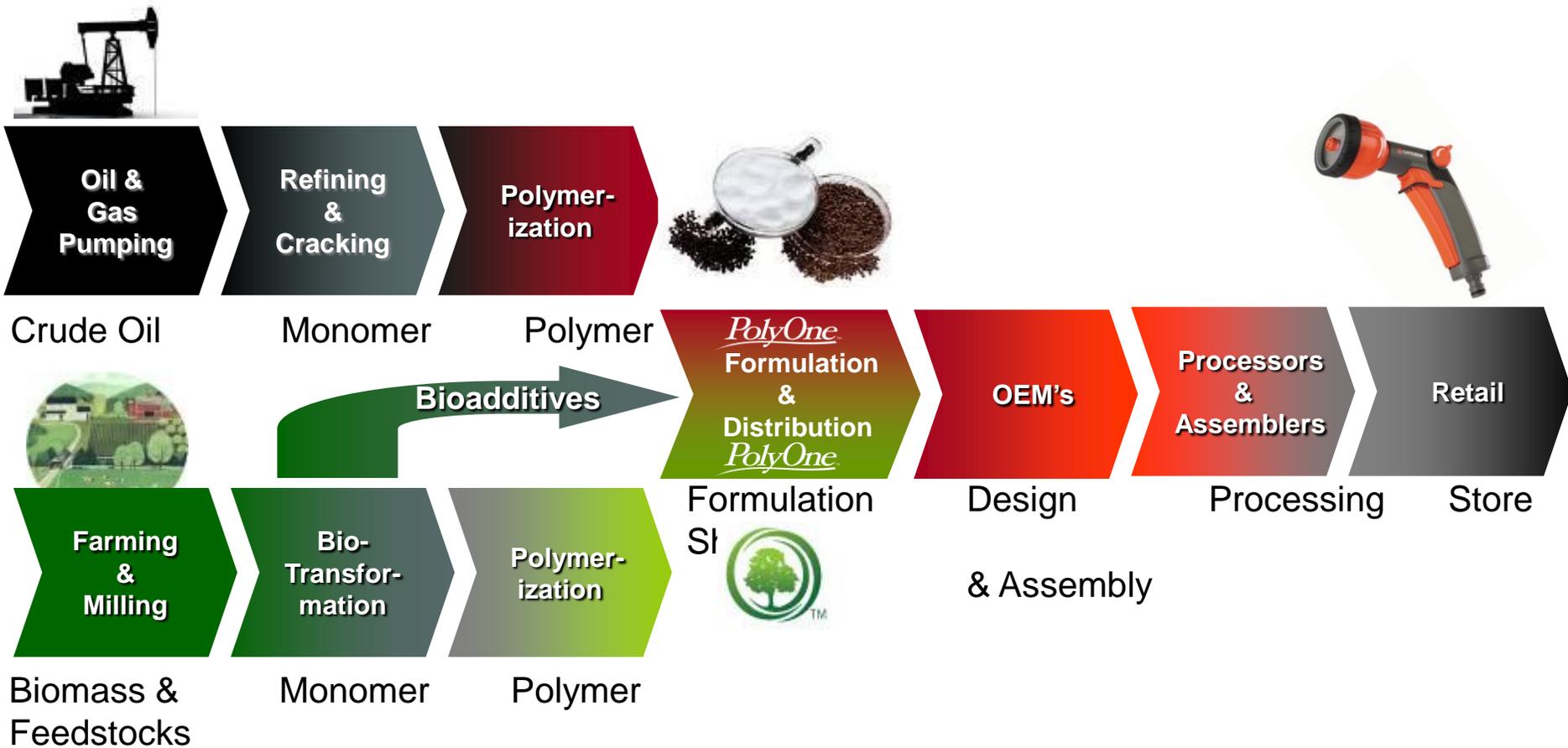
## ⇒ **Bio-fillers and bio-fibers**

- ⇒ Bio-fillers
  - ✓ Derived from natural sources (wood, corn husks, peanut shells, lobster shells, feathers, others)
  - ✓ Typically used to reduce costs
- ⇒ Bio-fibers
  - ✓ Natural fibrous materials (cellulose, hemp, flax, cotton, etc.)
  - ✓ Often enhance material properties through reinforcement

## ⇒ **Bio-plasticizers**



# PolyOne connects raw material suppliers to market needs



PolyOne connects raw material suppliers to market needs



# PolyOne Biomaterial Solutions

- ⇒ reSound<sub>™</sub>
  - ⇒ Bio-derived containing engineered material
- ⇒ OnColor<sup>™</sup> BIO
  - ⇒ Composting compliant colorants for bio-derived and bio-degradable polymers
- ⇒ OnCap<sup>™</sup> BIO
  - ⇒ Performance enhancement additives bio-derived and bio-degradable polymers
- ⇒ Smartbatch<sup>™</sup> BIO
  - ⇒ Fiber treatment to improve performance of recycled fibers in WPC
- ⇒ GLS OnFlex<sup>™</sup> BIO & GLS Versaflex<sup>™</sup> BIO
  - ⇒ Bio-derived containing TPE's
  - ⇒ Glass filled & halogen free flame retardant
  - ⇒ Up to 70% biogenic carbon
- ⇒ Aquamix
  - ⇒ Natural rubber latex
- ⇒ reFlex
  - ⇒ Bio-derived plasticizer
- ⇒ Producer Services
  - ✓ Toll compounding of biopolymers including starch compounds
- ⇒ Distribution Services

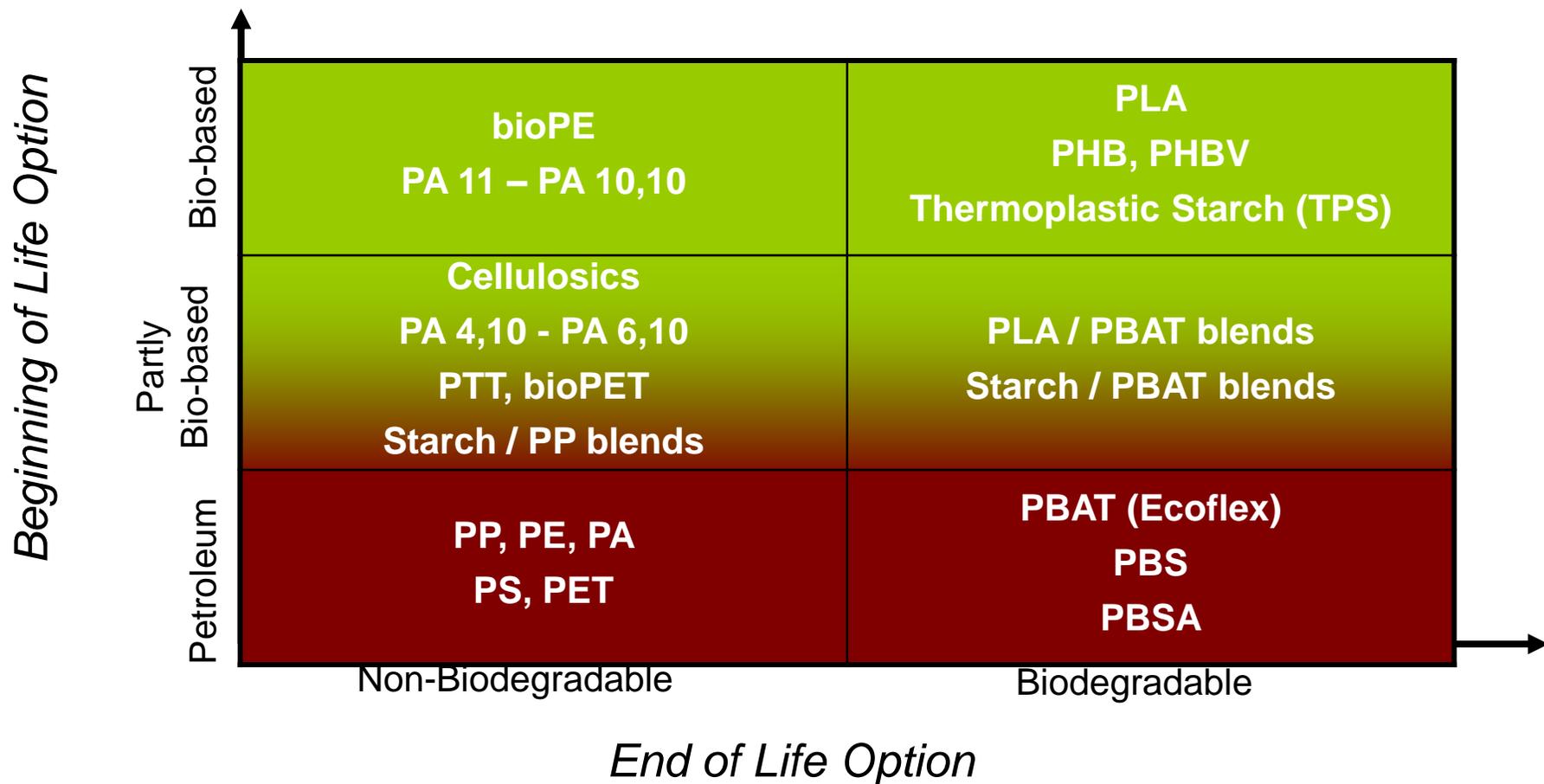


The miracles of science<sup>™</sup>





# Working with new materials



A good understanding of customer's objectives is key



# OnColor™ BIO & OnCap™ BIO



## ⇒ PolyOne's Family of Biopolymer Masterbatch Technologies

- ⇒ **OnColor™ Bio:** Color masterbatches
- ⇒ **OnCap™ Bio:** Additive masterbatches
- ⇒ **OnColor™ Bio Liquid:** Liquid color concentrates
- ⇒ **SmartBatch™ Bio:** Color & Additive masterbatches combined

## ⇒ PolyOne is a registered masterbatch supplier : Careful selection of pigments and additives

Pigments tested by OWS

## Certification according to EN13432 for a full range of colors

- ⇒ Several grades are certified
  - ✓ DIN CERTCO
  - ✓ VINÇOTTE

## ⇒ Optimized for Specific Biopolymers

- ⇒ PLA, PHA (PHB, PHBV)
- ⇒ BioPolyesters & Starch Blends

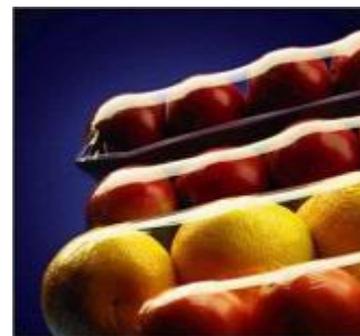




# OnColor™ BIO & OnCap™ BIO

- **Suitable for a wide range**
- **of conversion technologies**

- Injection Molding
- Sheet Extrusion
- Film Extrusion
- Extrusion Blow Molding
- Coating Extrusion, ...



- **Applications and End Markets**

- Films (stretch and shrink)
- Netting Punnets, Trays
- Cups , containers
- Bottles
- Waste and shopping bags, ...



# OnColor™ Bio

Color masterbatches for all biodegradable polymers :PLA, starch blends, biopolyesters





# OnColor™ BIO : Color Concentrates

Product Feature
<ul style="list-style-type: none"> <li>• In compliance with EN13432</li> <li>• Pre-tested range of colour concentrates               <ul style="list-style-type: none"> <li>Din Certco &amp; Vinçotte</li> <li>Certified, listed or disclosed formulations</li> </ul> </li> <li>• Pigments tested by OWS               <ul style="list-style-type: none"> <li>Heavy metal content</li> <li>Toxicity</li> <li>Disintegration</li> </ul> </li> <li>• Color matching &amp; Pantone references</li> </ul>



Application
<ul style="list-style-type: none"> <li>• All application</li> </ul>

Processing Technology
<ul style="list-style-type: none"> <li>• All processing technologies</li> </ul>

Product
Transparent, translucent & opaque
Translucent & opaque

Polymer	LDR
PLA & Compounds	1-2 %
PHB(V), Starch, BioPolyester	1-5 %



# OnColor™ BIO : SPD (Single Pigment Dispersion)

Product Feature
<ul style="list-style-type: none"> <li>• Single Dispersion Dyes</li> <li>• In compliance with EN13432</li> <li>• Pre-tested range of colour concentrates Din Certco &amp; Vinçotte Certified, listed or disclosed formulations</li> <li>• Color matching &amp; Pantone references</li> </ul>



Application
<ul style="list-style-type: none"> <li>• Fibers &amp; Filaments</li> </ul>

Polymer	LDR
• PLA & Compounds	• 1 – 2 %

Product	
<b>Blue</b>	<b>CC10105945BG</b>
<b>Green</b>	<b>CC10105947BG</b>
<b>Yellow</b>	<b>CC10105948BG</b>
<b>Yellow</b>	<b>CC10105949BG</b>
<b>Red</b>	<b>CC10101220BG</b>
<b>Brown</b>	<b>CC10105946BG</b>
<b>White</b>	<b>CC10053489BG</b>
<b>Black</b>	<b>CC10085911BG</b>





# OnColor™ BIO : Liquid Color Concentrates

## Product Feature

- 100 % biobased Carrier
- In compliance with EN 13432
- Accurate Dosing
- Excellent Dispersion
- Ideal for transparent applications



## Customer Benefit

- Low dosing
  - Minimal pigment loading
  - Maximising part appearance
  - Excellent compatibility
  - Maintains product performance
- **PolyOne would facilitate change over to liquid dosing.**



## Application

- Bottles

## Processing Technology

- ISBN
- Extrusion Blow Moulding

## Product

Custom Made  
Custom Made

## Polymer

PLA & PLA blends  
Starch & BioPolyester

## LDR

0.2-0.4 %  
0.2-0.4 %



# OnCap™ Bio

**Additive masterbatches  
for all biodegradable polymers :  
PLA, starch blends, biopolyesters**





# OnCap™ BIO : Additive Masterbatches

## Processing Improvement

- ⊙ Slip
- ⊙ Antiblock
- ⊙ Antistatic
- ⊙ Mould Release
- ⊙ Melt Flow Improver
- ⊙ Melt strength improver
- ⊙ Impact modifier

## Application Performance Improvement

- ⊙ Denesting
- ⊙ Impact modifier
- ⊙ UV barrier
- ⊙ Blue Tone
- ⊙ Fillers

## Processing in Development

- ⊙ Reactive Melt Strength improver
- ⊙ Processing aids
- ⊙ New impact modifiers

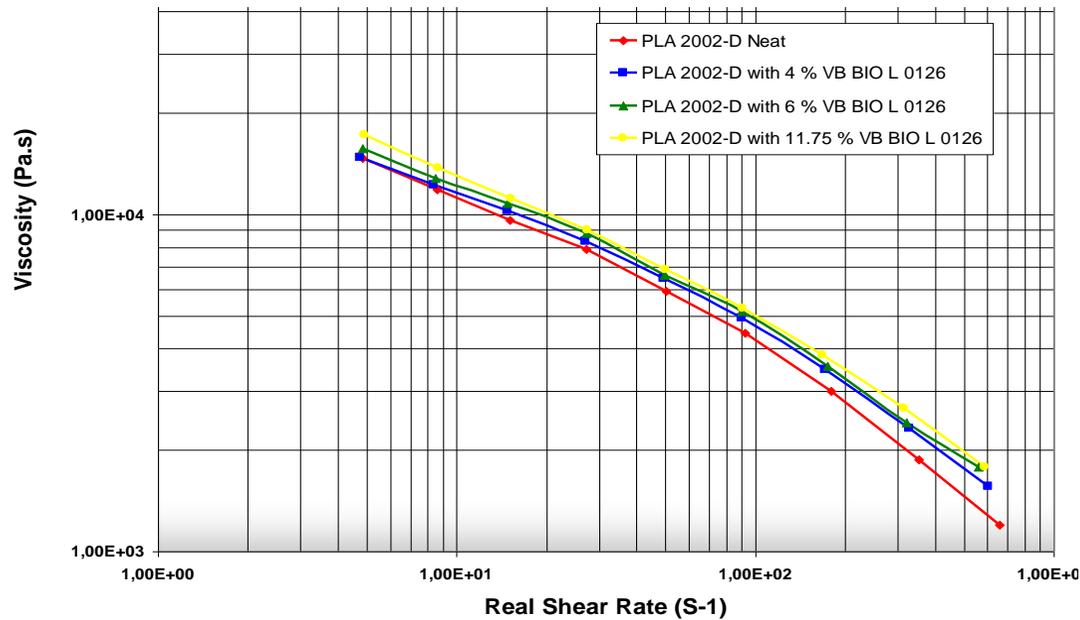
## Performance in Development

- ⊙ Plasticizers
- ⊙ Foaming Agent
- ⊙ Hydrolytic Stabilizers
- ⊙ Identification



# OnCap™ BIO : Melt strength Enhancer

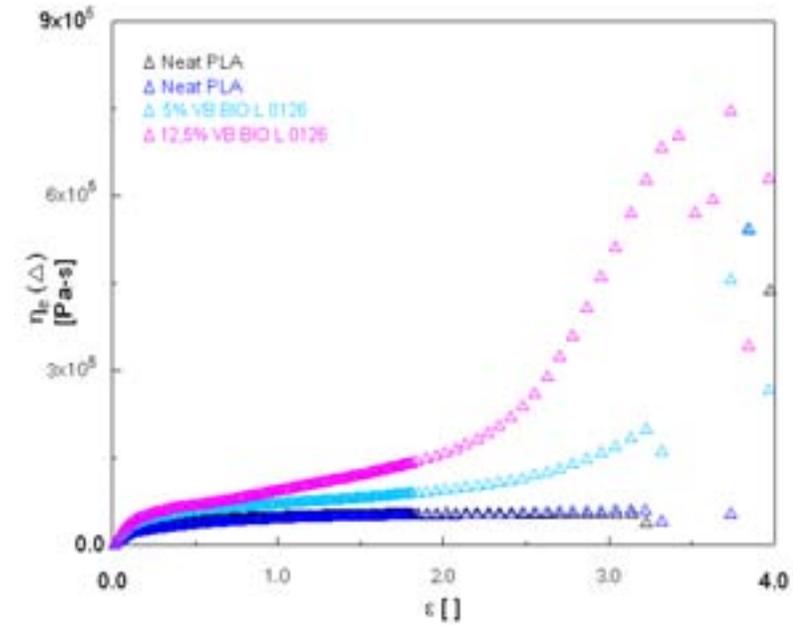
- VB BIO L 0126 creates a physical network with PLA and provides a high resistance to break in the melt



Capillary rheometer

PLA 2002D

(Melt temperature = 178° C)



Elongational viscosity  $\eta_e$  / Deformation  $\epsilon$  (%)

Temperature : 150° C

Rate : 1 s<sup>-1</sup>

Effect of VB BIO L 0126 :

$\eta_e$  increases = strain hardening appears

- Remark : VB BIO L 0126 provides a slight haze



# OnCap™ BIO : Impact improver



**Neat PLA :  
Brittle failure**

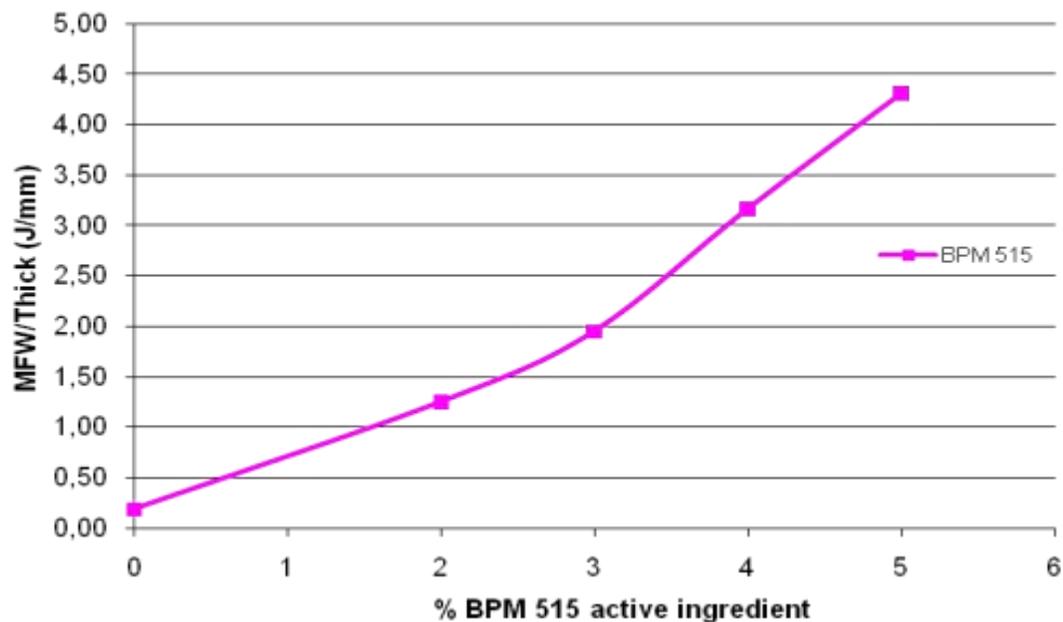


**12,5% IM BIO L 9152 :  
Ductile failure**

**Paraloid BPM 515**

**Ref : IM BIO L 9152**

- **Test method : ASTM D 5420**



Nature works 4043D PLA, 15 mil sheet



Thank you.



# OnCap™ BIO : Processing Improvement

Product	Function	Carrier	LDR (%)	EN 13432 up to (%)	Application
AB BIO L 4938	Antiblock	PLA	1 - 2	10	Extrusion (film, sheet)
SL BIO L 4939	Slip	PLA	5 - 10	10	Extrusion (film, sheet)
AS BIO L 6043	Antistatic	PLA	2 - 3	3	Extrusion / Injection
SL BIO L 6169	Mould release	PLA	2.5 - 5	5	Injection
MF BIO L 2880	Melt Flow Improver	PLA	2.5 - 5	100	Injection
VB BIO L 0126	Melt Strength Enhancer	PLA	2.5 - 5	2.5	Extrusion (film, sheet)
IM BIO L 9152	Impact Modifier (BPM 515)	PLA	2.5 - 10	2.5	Extrusion (film, sheet)
IM BIO L 2585	Impact Modifier	PLA	2.5 - 10	2.5	Extrusion (sheet)
IM BIO L 5978	Impact Modifier (BPM 520)	PLA	2.5 - 10	2.5	Injection
NA BIO L 6951	Filler (Talc)	PLA	from 5 %	100	Extrusion / Injection
PL BIO L 8540	Filler (CaCO3)	PLA	from 5 %	81	Extrusion (film, sheet)

AB BIO E 9528	Antiblock	Biopolyester	1 - 3	100	Film extrusion
SL BIO E 8856	Slip	Biopolyester	2 - 4	100	Film extrusion
ABSL BIO E 7520	Antiblock & Slip	Biopolyester	1 - 2	100	Film extrusion
AS BIO E 4960	Antistatic	Biopolyester	3 - 5	100	Film extrusion
PB BIO E 2148	Filler (Talc)	Biopolyester	from 5 %	100	Extrusion / Injection
PB BIO E 2151	Filler (CaCO3)	Biopolyester	from 5 %	81	Film extrusion



# OnCap™ BIO : Application Performance Improvement

Product	Function	Carrier	LDR (%)	EN 13432 up to (%)	Application
ABAS BIO L 3494	Denesting	PLA	5 - 10	100	Thermoformed trays
IM BIO L 9152	Impact Modifier	PLA	2.5 - 10	2.5	Extrusion (film, sheet)
IM BIO L 2585	Impact Modifier	PLA	2.5 - 10	2.5	Extrusion (sheet)
IM BIO L 5978	Impact Modifier	PLA	2.5 - 10	2.5	Injection
UVF BIO L 4627	UV Barrier (200 – 380 nm)	PLA	3 - 5	13	Sheet / Thick articles
UVF BIO L 4626	UV Barrier (200 – 390 nm)	PLA	3 - 5	10	Sheet / Thick articles
UVF BIO L 5309	UV Barrier (200 – 380 nm)	PLA	3 - 5	10	Film / Thin articles
OB BIO L 0234	Blue Tone	PLA	1 - 2	100	Extrusion / Injection

