

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



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

- A leading, global provider of specialized polymer materials, services and end-to-end business solutions
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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.

**Regional
Headquarters**



Manufacturing



Sales/Service



Warehouse



**Manufacturing
Sales/Service**



**Warehouse and
Sales/Service**





Facility Locations - Europe



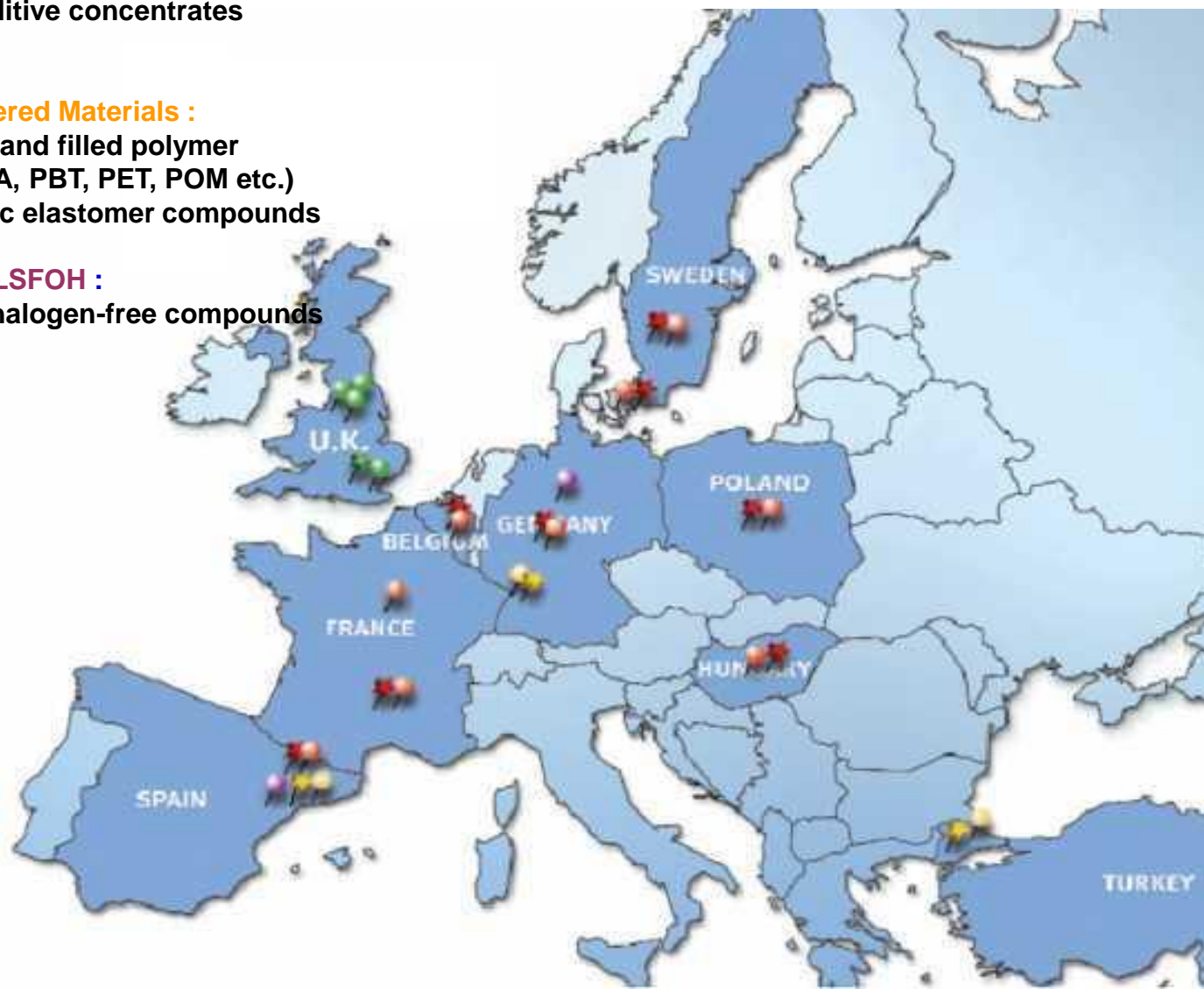
Colors & Additives :
color & additive concentrates



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



LSFOH :
flame retardant, halogen-free compounds

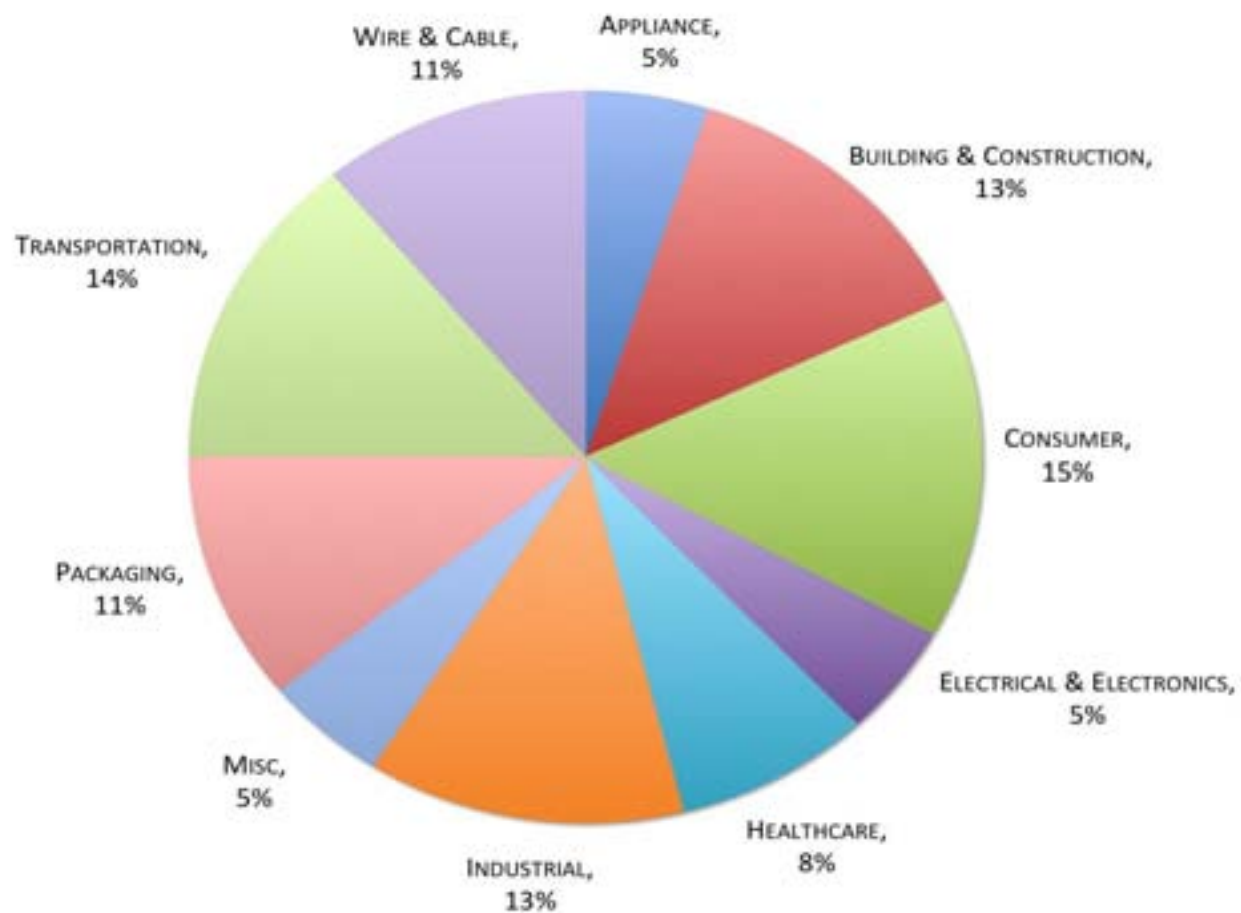




Industries Served

2010 Sales by Industry

(% of global revenues by industry segment)





Products / Services Overview



Color and Additives



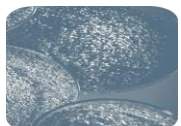
Specialty Inks and Polymer Systems



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

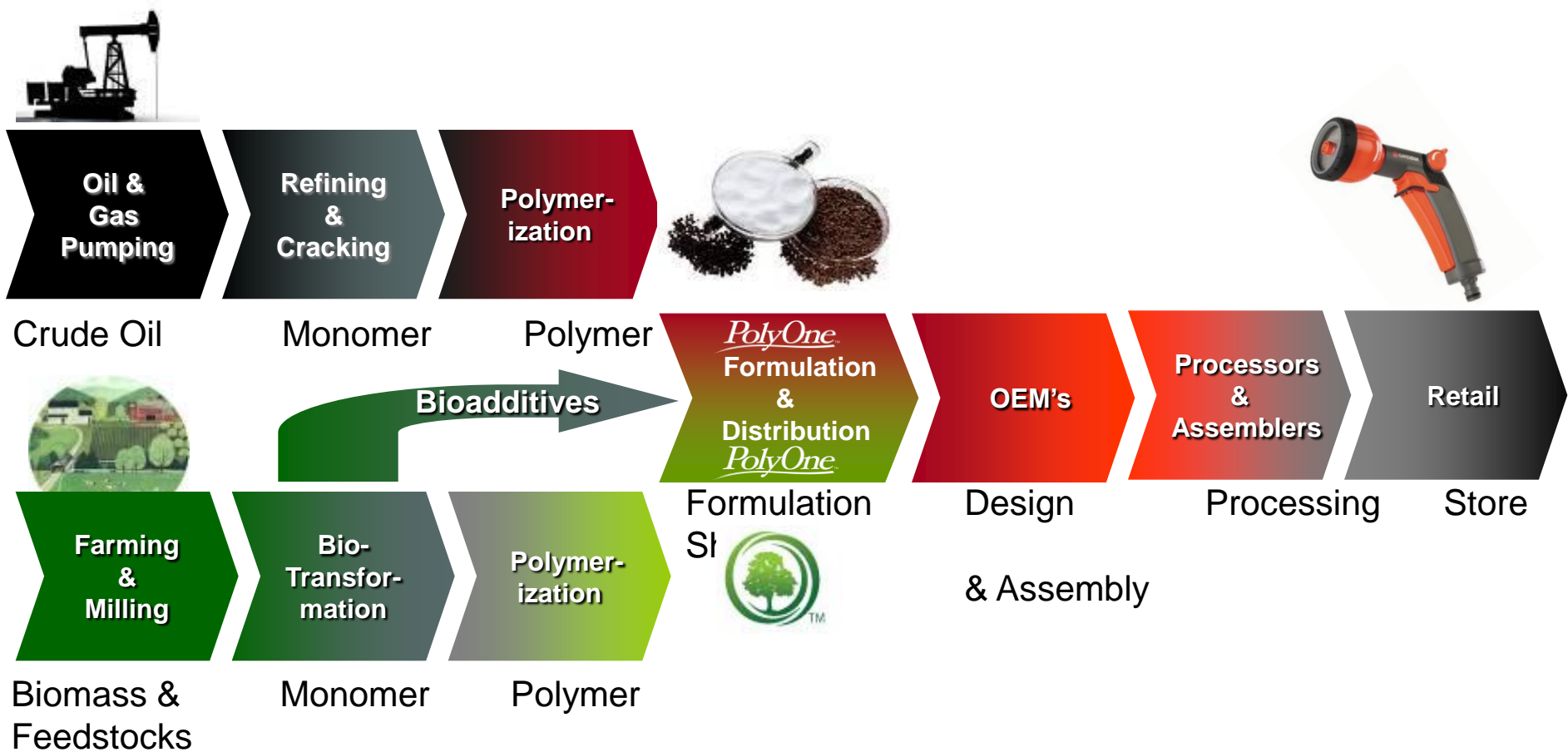
⇒ **Bio-fillers and bio-fibers**

- ⇒ 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[™]
 - ⇒ Bio-derived containing engineered material
- ⇒ OnColor[™] BIO
 - ⇒ Composting compliant colorants for bio-derived and bio-degradable polymers
- ⇒ OnCap[™] BIO
 - ⇒ Performance enhancement additives bio-derived and bio-degradable polymers
- ⇒ Smartbatch[™] BIO
 - ⇒ Fiber treatment to improve performance of recycled fibers in WPC
- ⇒ GLS OnFlex[™] BIO & GLS Versaflex[™] 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

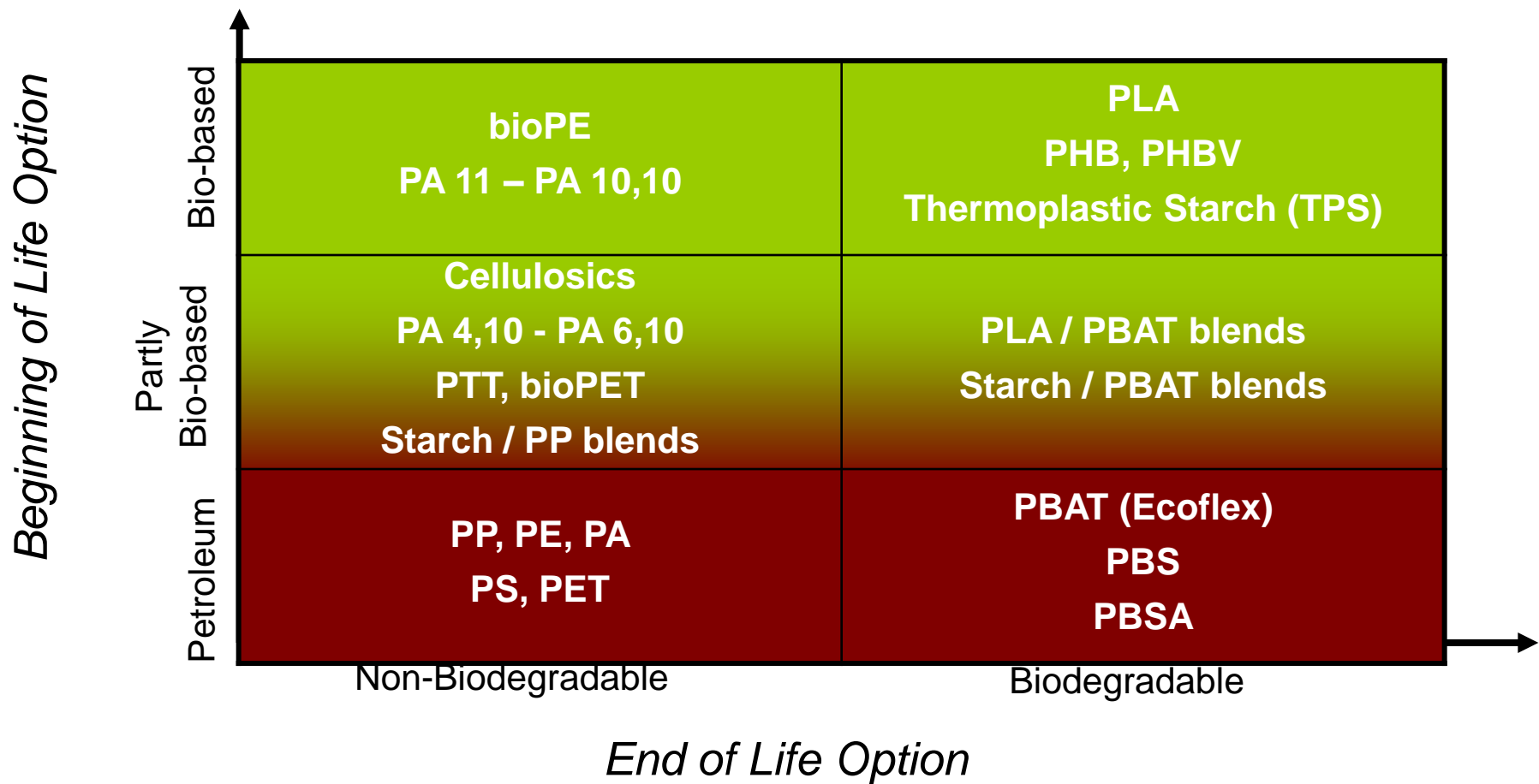


The miracles of science[™]





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

- In compliance with EN13432
- Pre-tested range of colour concentrates
 - Din Certco & Vinçotte
 - Certified, listed or disclosed formulations
- Pigments tested by OWS
 - Heavy metal content
 - Toxicity
 - Disintegration
- Color matching & Pantone references



Application

- All application

Processing Technology

- All processing technologies

Product

Transparent, translucent & opaque
Translucent & opaque

Polymer

PLA & Compounds
PHB(V), Starch, BioPolyester

LDR

1-2 %
1-5 %



OnColor™ BIO : SPD (Single Pigment Dispersion)

Product Feature

- Single Dispersion Dyes
- In compliance with EN13432
- Pre-tested range of colour concentrates
Din Certco & Vinçotte
Certified, listed or disclosed formulations
- Color matching & Pantone references



Application

- Fibers & Filaments

Polymer

- PLA & Compounds

LDR

- 1 – 2 %

Product

Blue	CC10105945BG
Green	CC10105947BG
Yellow	CC10105948BG
Yellow	CC10105949BG
Red	CC10101220BG
Brown	CC10105946BG
White	CC10053489BG
Black	CC10085911BG





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

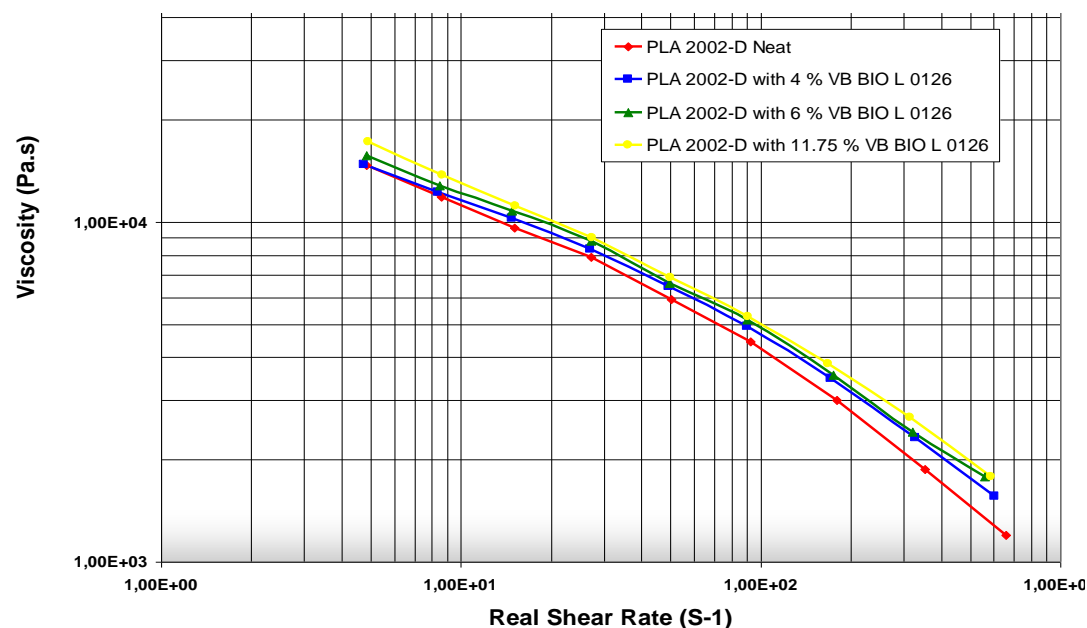
Performance in Development

- ◎ Plasticizers
- ◎ Foaming Agent
- ◎ Hydrolytic Stabilizers
- ◎ Identification



OnCap™ BIO : Melt strength Enhancer

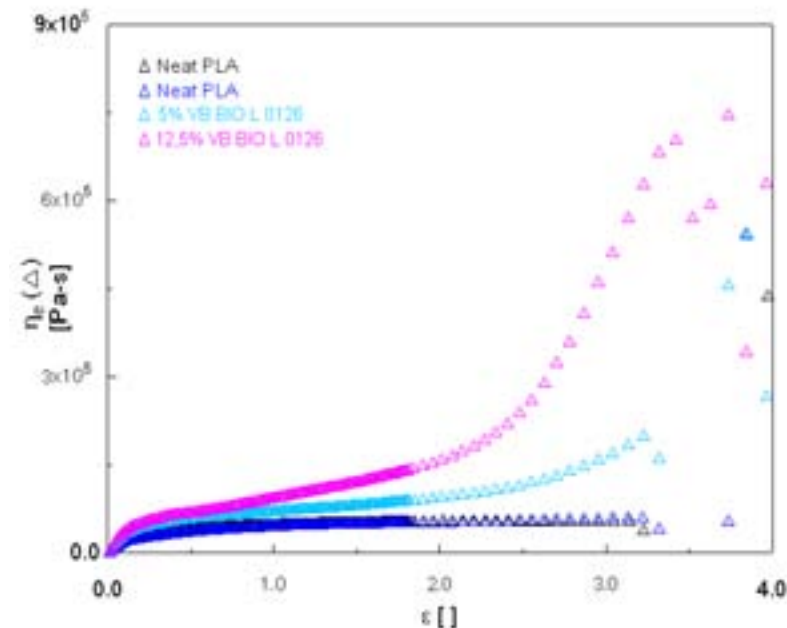
- VB BIO L 0126 creates a physical network with PLA and provides a high resistance to break in the melt



Capillary rheometer

PLA 2002D

(Melt temperature = 178° C)



Elongational viscosity η_e / Deformation ϵ (%)

Temperature : 150° C

Rate : 1 s⁻¹

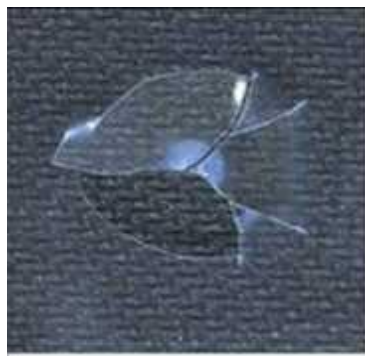
Effect of VB BIO L 0126 :

η_e increases = strain hardening appears

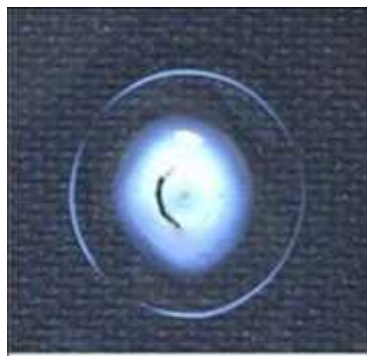
- Remark : VB BIO L 0126 provides a slight haze



OnCap™ BIO : Impact improver



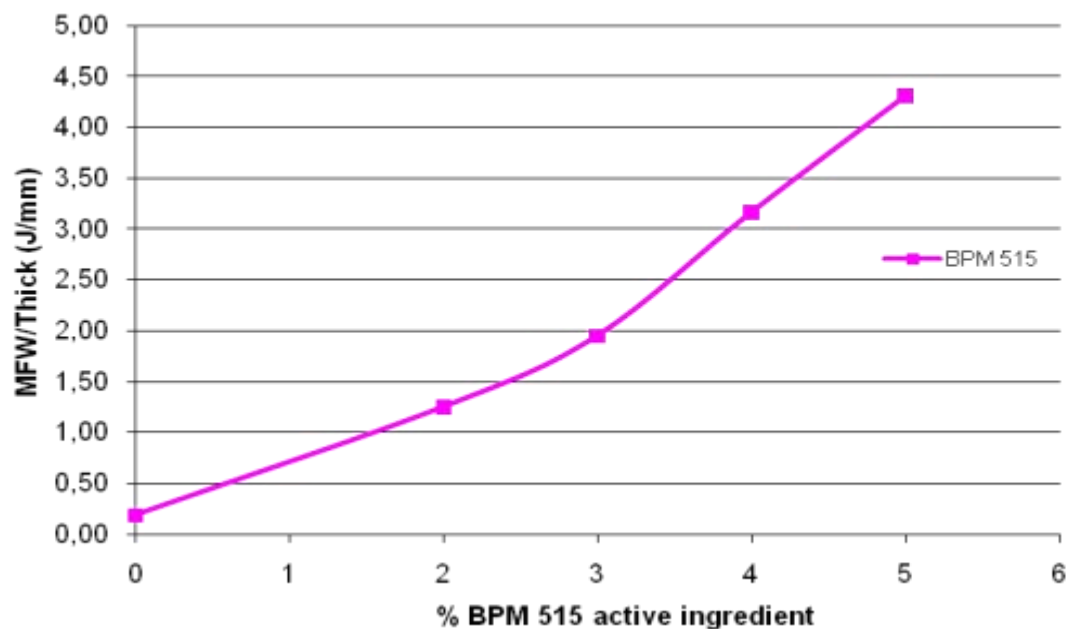
**Neat PLA :
Brittle failure**



**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 (CaCO ₃)	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 (CaCO ₃)	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

