



LAPOL[®]
Enabling Bioplastics

Lapol[®] HDT-P
Raising the
Heat
Deflection
Temperature
of PLA

LAPOL[®] HDT-P TECHNICAL BULLETIN

MARCH
2015

Poly(lactic acid) (PLA)

The Front Runner in Bioplastics

- ❑ Degradable thermoplastic resin
- ❑ Made from renewable resources
- ❑ Flexible or rigid
- ❑ Processed on standard converting equipment
- ❑ Multiple consumer and industrial applications



Limitations of PLA

Low Heat Deflection
Temperature (HDT)
50 - 60 °C

- Sticking and Deformation During Transport, Storage and Use

Brittleness

- Poor Impact Resistance

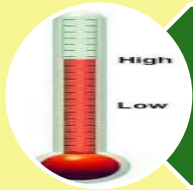
Long Mold Times

- Costly to Process

The Lapol[®] HDT-P Solution

- Lapol[®] HDT-P is a patent pending renewable additive for PLA which increases the heat resistance and toughness of PLA to enable it to be cost effectively processed.
- Applications include both disposable and durable goods such as, food service, automotive, electronic devices, credit card stock, etc.

Lapol[®] HDT-P Characteristics



Improves heat deflection temperature of PLA



Compostable and renewable



FDA compliant



Processes on standard converting equipment

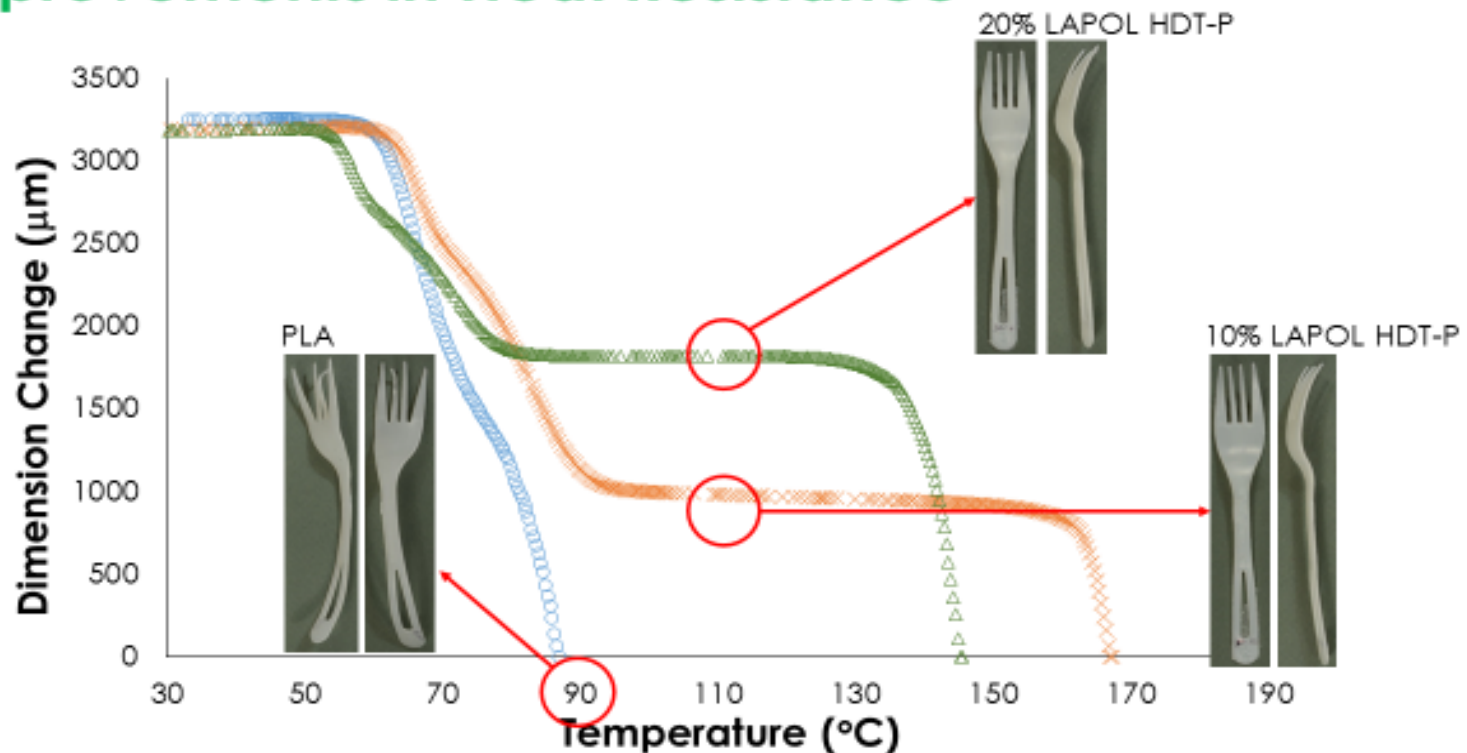
Lapol[®] HDT-P Concentration in NatureWorks Ingeo[™] PLA

PLA grades respond differently to Lapol[®] HDT-P at lower concentrations, but all show an improvement in their heat tolerance at $\leq 20\%$.

Concentrations of 10% show the best combination of cost effectiveness, mechanical and heat tolerance properties.

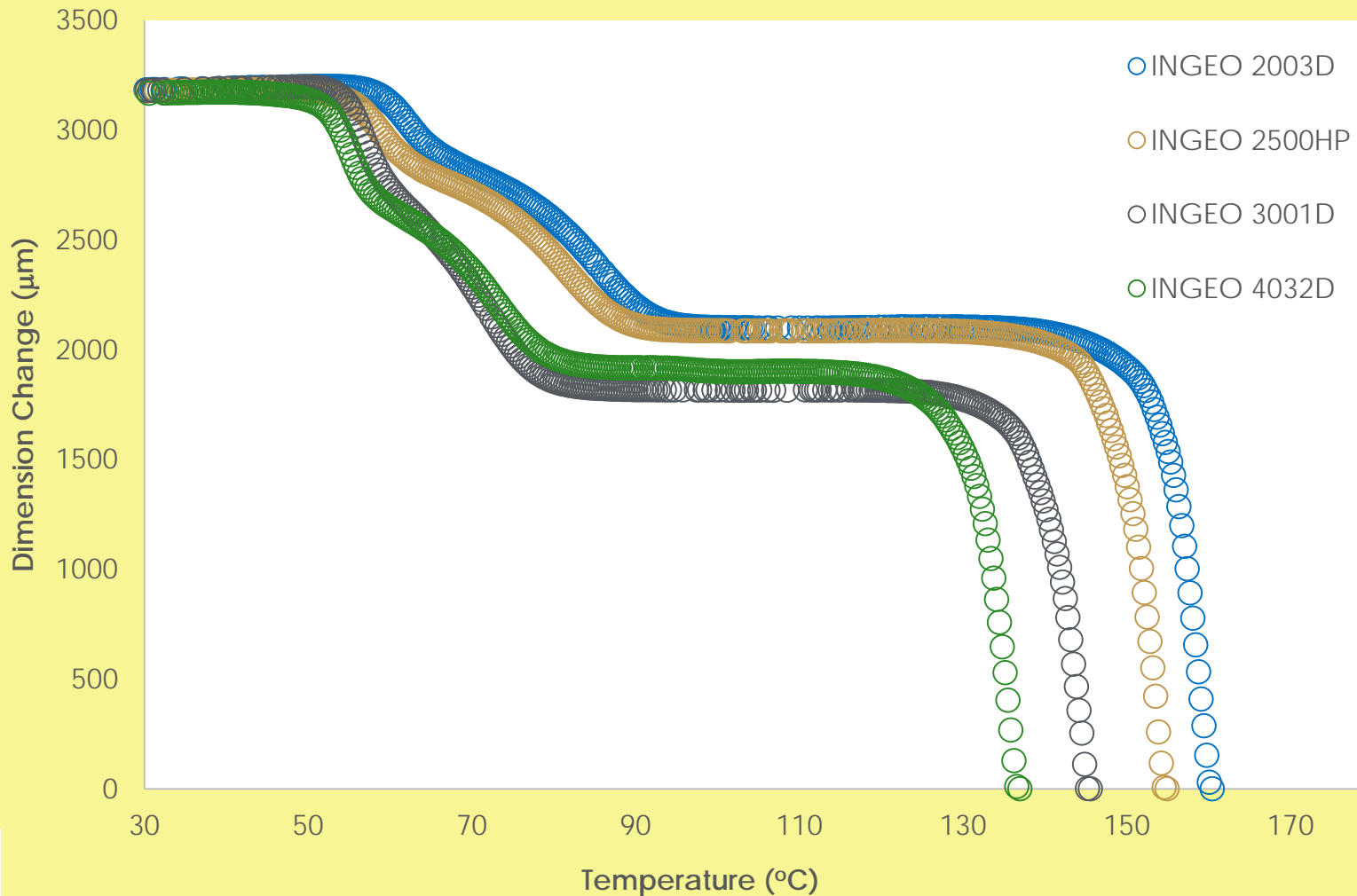
Lapol[®] HDT-P Thermal Mechanical Analysis in PLA 3001D

Improvements in Heat Resistance

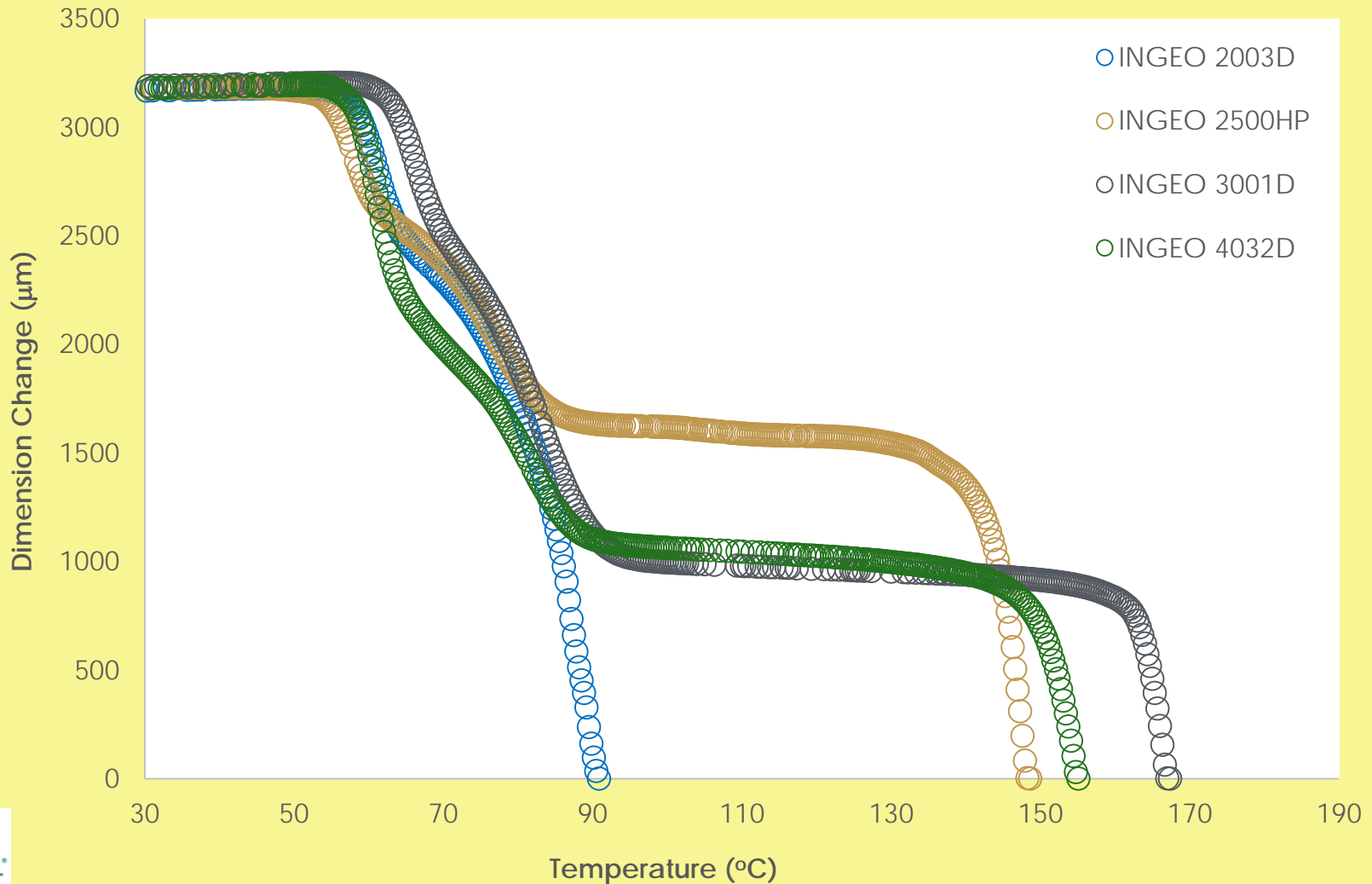


Hot water cutlery application test samples shown

Lapol[®] HDT-P in Various INGEO[™] Biopolymer Grades at 20%



Lapol[®] HDT-P in Various INGEO[™] Biopolymer Grades at 10%



Lapol[®] HDT-P Mechanical Properties in PLA 3001D

Flexural Properties	PLA 3001D	10% Lapol [®] HDT-P	20% Lapol [®] HDT-P
Modulus (MPa)	2800	2388	4625
Strength (MPa)	90	92	131
Toughness (MPa)	0.882	1.44	1.53

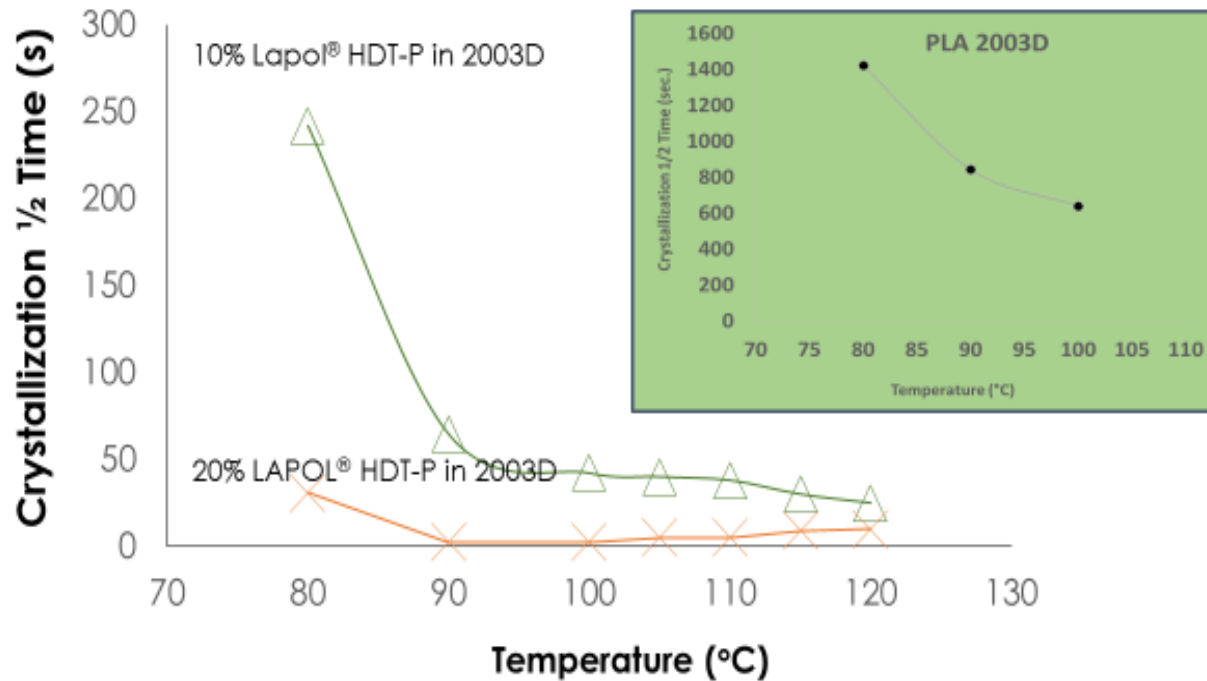
Lapol[®] HDT-P Tensile and Elongation in PLA 4032D

Tensile Properties	PLA 4032D	10% Lapol [®] HDT-P	20% Lapol [®] HDT-P
Tensile Modulus (MPa)	1263	1560	1296
Tensile Strength (MPa)	56	60	54
% Elongation	7	9	9

Lapol[®] HDT-P Tensile and Elongation in PLA 3001D

Tensile Properties	PLA 3001D	10% Lapol [®] HDT-P	20% Lapol [®] HDT-P
Tensile Modulus (MPa)	1276	1787	1138
Tensile Strength (MPa)	53	53	40
% Elongation	7	6	8

Production Throughput Improvement



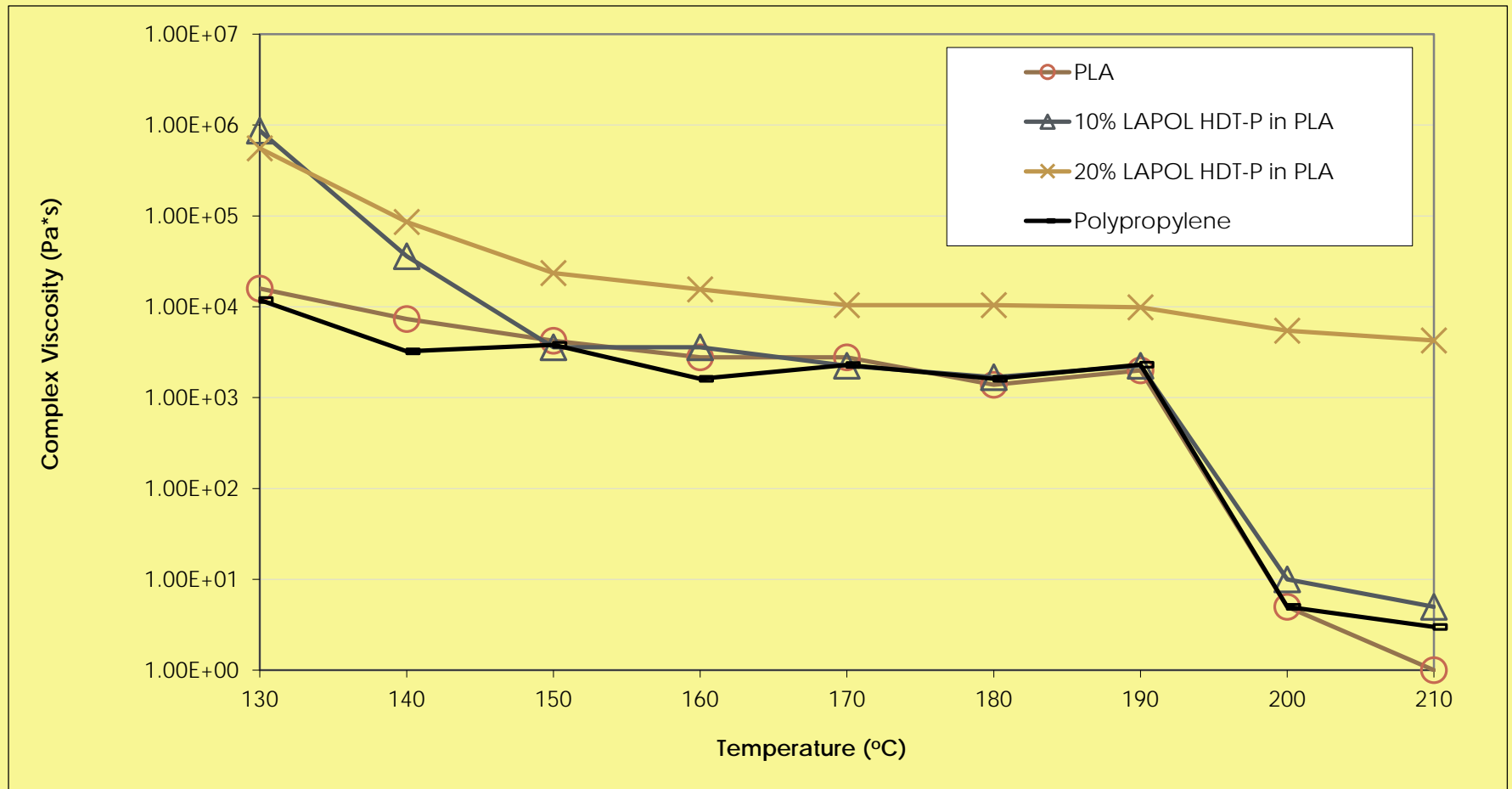
Production throughput rate has been observed to increase by as much as 40% using Lapol[®] HDT-P

PLA requires crystallization for increased HDT, but will distort when exposed at elevated temperatures rendering the parts unusable; whereas, PLA containing Lapol[®] HDT-P does not require crystallization and will not distort under elevated temperatures.



Complex Viscosity

PLA, Lapol[®] HDT-P/PLA Blends, and Polypropylene (130 - 210 °C)



Physical Properties of Lapol[®] HDT-P



Properties	Lapol [®] HDT-P
Bimodal Melting Point	110-120 ° C 170-180 ° C
Density	1.20 g/cc
Color	Off White
State	Solid Pellet

- ❑ Increases Heat Deflection Temperature of PLA
- ❑ Improves Toughness of PLA Products
- ❑ Excellent miscibility with commercial PLA
- ❑ FDA Compliant
- ❑ Compostable & Renewable

Summary

Lapol[®] HDT-P Attributes

- ❑ Increases heat deflection temperatures in PLA to greater than 150°C.
- ❑ Improves toughness of PLA products.
- ❑ Lapol[®] HDT-P does not require crystallizing and will not distort under elevated temperatures.
- ❑ Thermoforming cycle time has been shown to be reduced by 40%.
- ❑ Can be added directly at the thermoformer extruder or injection molder.

Lapol[®] HDT-P
Biopolymer
Resin is:

- ❑ Renewable
- ❑ Compostable
- ❑ FDA Compliant



www.lapol.net

3757 State Street Suite 2A

Santa Barbara, CA 93105

805-456-7950