WACKER

CREATING TOMORROW'S SOLUTIONS

VINNEX®

ADDITIVES FOR BIOPOLYMERS

VINNEX® – ENABLING THE NEXT GENERATION OF BIOPLASTICS

WACKER supports the switch towards a circular economy. This also means rethinking how we produce and use plastics.

We need to eliminate unnecessary plastic items. Recycle all plastic waste for economic purposes and thereby eliminate it from the environment. Innovate to ensure that the plastics we do require are reusable, recyclable or compostable/biodegradable.*

VINNEX® helps you take the next steps towards a circular economy. VINNEX® enables biodegradable polymers and starches to be used in new applications with customized properties. Thus VINNEX® blends can be processed on unmodified thermoplastic equipment.

* See: “Plastics and the circular economy” by The Ellen MacArthur Foundation

Contents

BIOPLASTICS HAVE A GREAT FUTURE
LET'S ENABLE IT TODAY

In the past two decades, many new polymers from renewable feedstocks have been developed. Starch was rediscovered as a plastic material. Polylactic acid (PLA) and polyhydroxyalkanoate/polyhydroxybutyrate (PHA/PHB) produced from sugars and starches have become important raw materials. Still, these biopolymers come with drawbacks: lower material performance, relatively high cost for production and problems in processing inhibit their broad acceptance.

VINNEX® is an additive and enabler which allows the combination of several biopolymers. The resulting performance and processing becomes comparable to traditional polymers or even better thanks to added functionalities.

Classification of Biopolymers

DINCERTCO, a globally recognized certification body, has introduced a nomenclature which makes it easier to recognize the ecological impact of so-called biopolymers.

Bio-Based Polymers

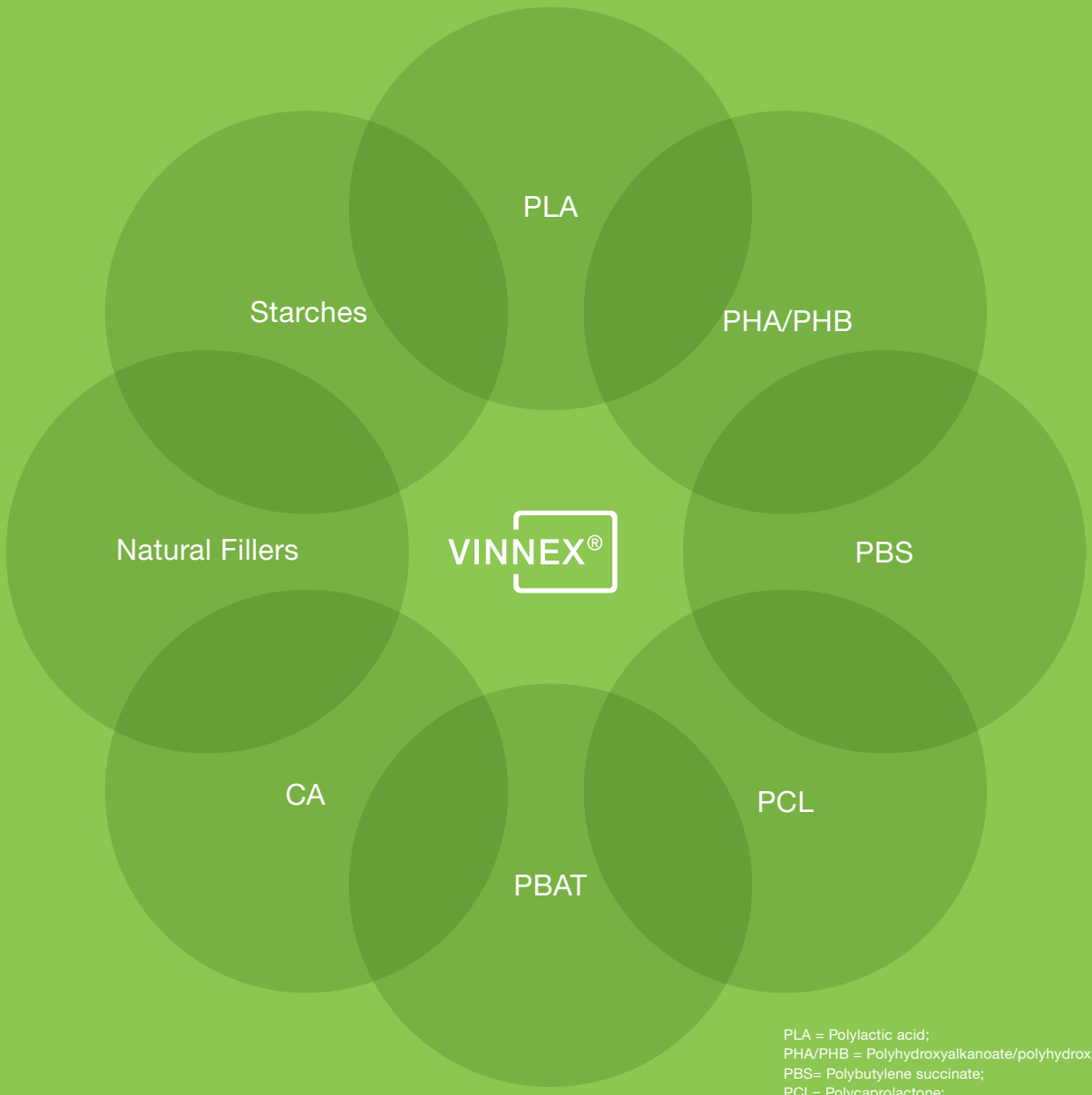
Bio-based polymers consist to a certain extent of biomass.
The use of renewable raw materials is demonstrated on "bio-based" labels:

Compostable and Biodegradable Polymers

Compostable and biodegradable polymers must be degradable by microorganisms, but they are not necessarily bio-based. They are classified according to the environmental conditions that are necessary for the degradation process.
Compostable: polymer will compost only in industrial composting facilities (at temperatures between 55 °C to 60 °C).
Home compostable: polymer will compost at lower temperatures, so it can go into the garden compost heap.
Biodegradable in soil: polymer will completely biodegrade in the soil without adversely affecting the environment.
Biodegradable in fresh water, as well as marine water: polymer will biodegrade in a natural fresh water environment without adversely affecting it. Biodegradation in salt water is even more challenging.

VINNEX®: YOUR DOOR TO A NEW WORLD OF BIOPLASTICS

VINNEX® is a binder system based on poly(vinyl acetate) which acts as an enabler: it brings components into a nearly perfect synergistic relationship. Typically used in a concentration between 5 and 20%, VINNEX® allows the combination of the most important biopolymers such as starch, PLA, PHA/PHB or PBS, leading to a new class of individually designable polymer blends with a wide array of properties.



PLA = Polylactic acid;
PHA/PHB = Polyhydroxyalkanoate/polyhydroxybutyrate;
PBS= Polybutylene succinate;
PCL= Polycaprolactone;
PBAT = Polybutylene adipate terephthalate;
CA = Cellulose acetate

VINNEX® grades are vinyl-acetate-based homo-, co- or terpolymers available as powders (VINNEX® powder) or flakes and beads (VINNEX® resin). VINNEX® enables different biodegradable polymeric raw materials to be combined, giving you the leverage to individually improve critical characteristics of bioplastics.

VINNEX® Enables the Processing of Biopolymers via:

- Injection molding
- Extrusion
- Blow molding
- Thermoforming
- Transfer molding
- Calendering

VINNEX® Opens Up a World of New Applications in:

- Agriculture
- Construction
- Consumer goods
- Electronics
- Food
- Medical applications
- Packaging

Food Approved

For most VINNEX® grades food contact information for regulations such as FDA, BfR etc. is available.*

Biodegradable

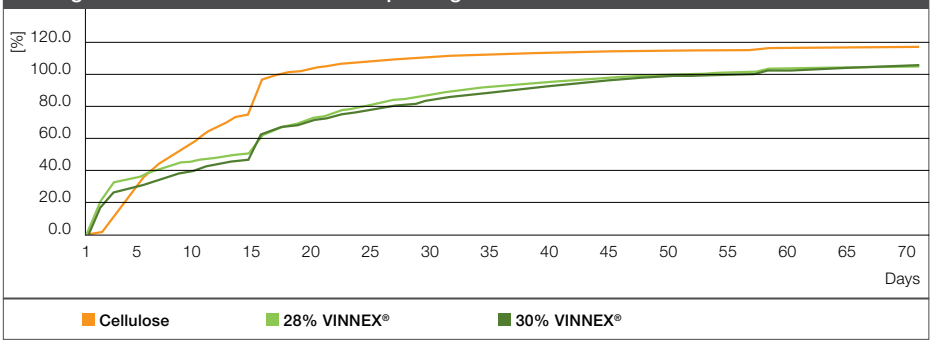
For example, two blends of VINNEX® with different biopolymers passed the industrial composting test (ISO 14855 of EN 13432).

- TPS/PLA/VINNEX® blend with 28% and 30% VINNEX® 2504 (see graph)
- PHA/PHB/VINNEX® blend with 25% VINNEX® 8880
- For more detailed information, please refer to our technical service.

Effects of VINNEX® in Bioplastics

Blend with:	VINNEX® Powder	VINNEX® Resin
PLA	• Improved impact strength • Enhanced flexibility • Improved compatibility with polar fillers and other biopolymers • Improved performance in film sealing	• Increased melt strength • Improved processability • Reduced noise of PLA films • Maintained transparency • Good performance in film sealing • Improved adhesion to paper
PHA/PHB	• Enhanced flexibility • Improved compatibility with polar fillers and other biopolymers	• Enhanced flexibility • Higher mechanical toughness • Increased melt strength • Optimized crystallinity • Enables film blowing with PHB
PBS	• Enhanced flexibility • Improved compatibility with polar fillers and other biopolymers • Increased melt strength • Improved processability in extrusion and thermoforming	• Enhanced flexibility • Increased melt strength • No reduction in hardness or modulus

Biodegradation under Industrial Composting Conditions



Biodegradation of TPS/PLA/VINNEX® blends under industrial composting conditions (ISO 14855 of EN 13432). On a relative basis with cellulose as the reference substrate, values of 90.0% and 90.1% were calculated. As such, the 90% biodegradability criterion was reached in 65 days both on an absolute and on a relative basis.

* Please contact your WACKER respresentative regarding specific clearances.

VINNEX® AND PLA:
TAKING PLA TO NEW SHORES

Polylactic acid (PLA) is an aliphatic polyester. Due to its good physical and mechanical properties, it is a good candidate as replacement for petrochemical thermoplastics. VINNEX® is especially compatible with PLA and enhances its property profile, making it an even better substitute for bulk thermoplastics, e.g. in packaging applications.

Origin and Availability

PLA is produced from sugars, molasses, sugar beet juice, sulfite liquors and whey, as well as rice, wheat, corn and potato starches. In the near future, it is expected that PLA will be produced by the hydrolysis of lignocelluloses from wood, straw or corn stover as well as by enzymatic processes.

Classification: Compostable

PLA will degrade under typical industrial composting conditions.

Market Possibilities

Recent breakthroughs in lactide production and polymerization technology have opened up standard thermoplastic processing techniques:

- Sheet extrusion for thermoformed products
- Biaxially oriented film
- Blow molding
- Injection molding
- Fiber spinning

Typical Applications

In the past, PLA was mainly used for medical and specialty applications. Nowadays, typical applications for PLA include: packaging (cups, bottles, films, trays, shopping bags), textiles (shirts, furniture), nonwovens (diapers), electronics (mobile phone housing), and agricultural applications (blend with thermoplastic starches (TPS) for mulch films).

Profile of PLA

Advantages

- ✔ High gloss
- ✔ High stiffness
- ✔ Good mechanical properties
- ✔ High transparency

Profile of PLA/VINNEX® Blends (Combinations of Powder/Resin Possible)

With VINNEX® Powder

- ✔ Improved impact strength
- ✔ Enhanced flexibility
- ✔ Improved compatibility with polar fillers
- ✔ Improved compatibility with other biopolymers
- ✔ Improved performance in film sealing

With VINNEX® Resins

- ✔ Reduced noise of PLA films
- ✔ Improved processability
- ✔ Increased melt strength
- ✔ Maintains transparency
- ✔ Good performance in film sealing
- ✔ Improved adhesion to paper

PLA/VINNEX® blends are particularly suitable for food packaging. Most VINNEX® grades can be used in food contact applications.

VINNEX® AND PLA:
THE FUTURE, TODAY

PLA blends with VINNEX® enable new functions and applications while maintaining biodegradability. They can be easily processed via injection molding, extrusion, vacuum forming, thermoforming and film blowing.

VINNEX® Blends with PLA

VINNEX® blends with PLA are easy to process and can be mixed in any ratio.

Improved Properties

Depending on the use level, VINNEX® increases impact and melt strength and therefore improves processability (e.g. cutting, removing from reel, separation of film). VINNEX® works as a compatibilizer for materials such as starch and calcium carbonate, as well as other organic and inorganic fillers. VINNEX® resins additionally act as tackifiers in hot-melt adhesives and extrusion paper coatings.

Lower Melting Point

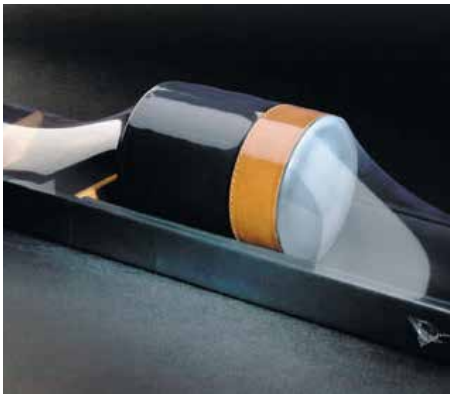
PLA/VINNEX® blends (e.g. with VINNEX® 2504 and 2505) produce translucent films and reduce the blend's melting point.

Improved Impact Strength

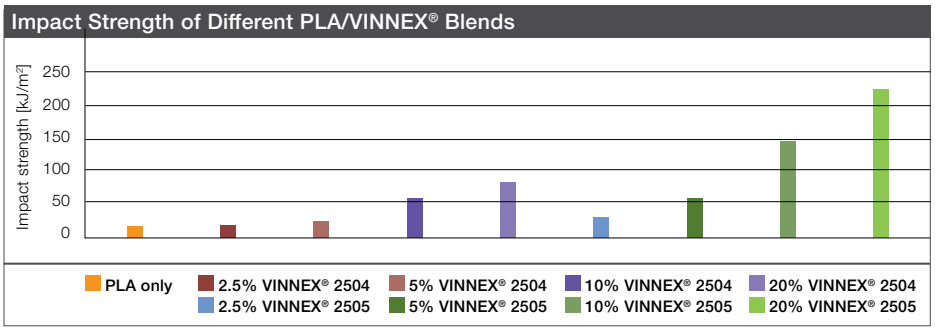
VINNEX® (e.g. 2504 and 2505) is an impact modifier for PLA (see graph).

This property is especially important for the increasing number of durable applications made out of bio-based polyersters.

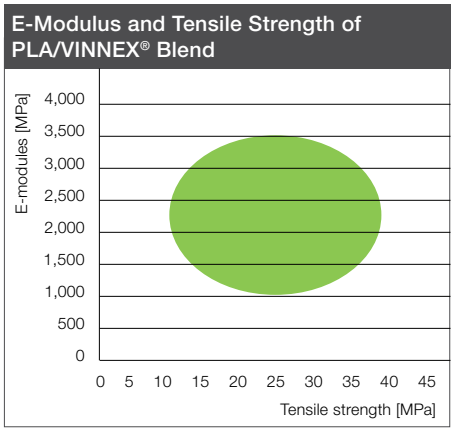
Make the move to more durability – VINNEX® significantly increases the impact strength of thermoplastic biopolymers.*



Highly transparent shrink films are made from a PLA/VINNEX® resin blend. Images courtesy of Moel.



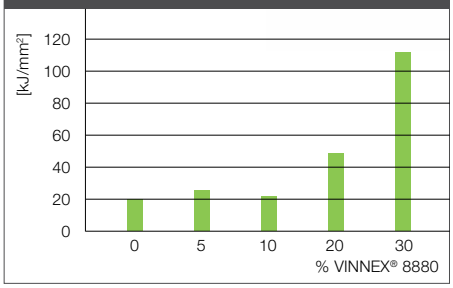
Achievable mechanical properties with PLA/TPS for injection molding and thermoforming.



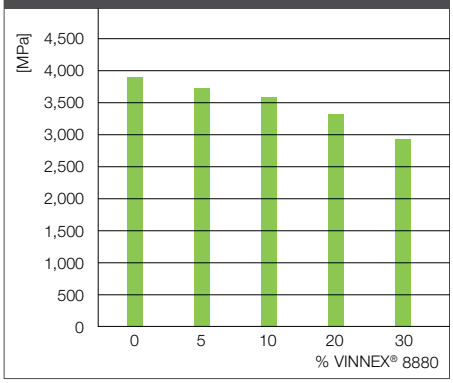
Achievable mechanical properties with PLA/TPS/VINNEX® blends for injection molding and thermoforming.

The effects of VINNEX® blends on impact strength are particularly beneficial, as they allow the material to do a better job of absorbing energy from shocks and impacts.*

Impact Strength of Different PLA / VINNEX® 8880 Blends



E-Modulus of Different PLA / VINNEX® 8880 Blends



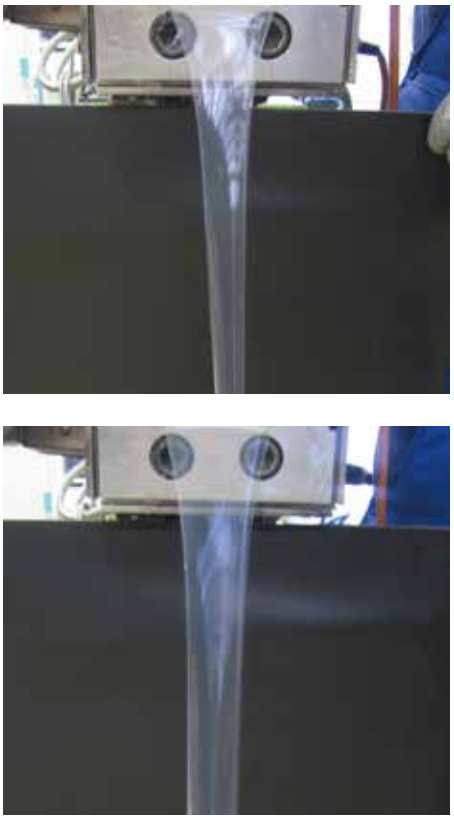
PLA/VINNEX® 8880 blend in blow film extrusion for highly transparent films.

Improved Characteristics for Transparent Films

With VINNEX® 8880, we offer a novel modifier that is especially useful in transparent PLA films and injection molding parts. By using 10 – 30% of VINNEX® 8880 in a PLA formulation:

- The “metallic” crackling sound of PLA is greatly reduced
- Mechanical properties are improved
- Processing properties are improved
- Processing temperature is decreased
- Compostability can be maintained
- Film-sealing properties are improved

With VINNEX® 2525, we offer a processing aid that improves the melt strength and stability of PLA blends. Transparency and high gloss of PLA are maintained.



Compared to pure PLA (top image) the PLA/VINNEX® 2525 blend (bottom image) exhibits improved melt strength.

* Product made using Luminy PLA - image courtesy of TotalEnergies Corbion

VINNEX® LA – PLA RESIN BLENDS: FOR DRY MIX WITH BIOPOLYMERS

Preblended PLA and VINNEX® compounds are effective solutions for more efficient processing of complete bioplastic solutions. They offer a wide range of options to meet all customer requirements.

The new compounds consisting of PLA and VINNEX® resins

- allow handling at ambient temperatures up to 30 °C
- make homogenization during compounding easier
- allow conversion of VINNEX® in dry mixes with biopolyesters

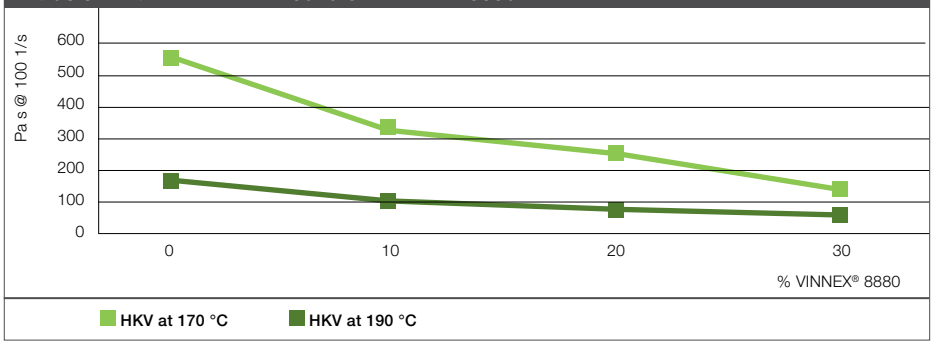
Incorporating VINNEX®

VINNEX® is highly compatible with various biodegradable polymers. Nevertheless, compounding steps are required to create the final blend comprising biodegradable polymer, fillers, functional additives and VINNEX® polymers. In the VINNEX® LA product series, compounding with PLA is already complete. VINNEX® LA products can be used for converting in a dry mix with biodegradable polymers, such as PLA.

A Comprehensive Portfolio

The VINNEX® LA series of products contain 60% PLA and 40% VINNEX® resin, as listed in our technical specification chart (see page 26). With these new products in our portfolio, interested customers can now find an option suitable for all their requirements.

Extrusion with VINNEX® LA 8040 or VINNEX® 8880



In 3D printing, VINNEX® LA products reduce melt viscositiy and increase the flow rate of PLA as shown in the figure above.

PLA with VINNEX® LA 2640

PLA with VINNEX® LA 2540

PLA with VINNEX® LA 8040

Here, 3D printed figures are displayed. Printing was performed with a dry mix of PLA and VINNEX® LA products. The printer (Tumaker NX PRO PELLETS 3D Printer) was able to print with pellets.

The relatively high heat distortion temperature of PHA/PHB makes it suitable for hot fill applications. PHA/PHB/VINNEX® blends have improved flexibility and mechanical toughness, as well as increased melt strength.

VINNEX® AND PHA/PHB:
WAKING A SLEEPING GIANT

Polyhydroxybutyrate (PHB) is a polyhydroxyalkanoate (PHA) which is produced via fermentation from renewable raw materials. It is a thermoplastic polyester with characteristics similar to the petrochemically produced polypropylene (PP). PHB is sometimes called the “sleeping giant” among the biopolymers due to its high market potential. VINNEX® resins can help realize this potential by enhancing the property profile and enlarging the application spectrum.

Profile of PHA/PHB

Advantages

- ✔ High heat resistance
- ✔ Low melt viscosity
- ✔ Wide modulus range
- ✔ Good biodegradability
- ✔ Good gas-barrier properties
- ✔ High crystallinity

Profile of PHB/VINNEX® Blends

With VINNEX® Powder

- ✔ Improved compatibility with polar fillers
- ✔ Improved compatibility with other biopolymers
- ✔ Enhanced flexibility

With VINNEX® Resins

- ✔ Optimized crystallinity
- ✔ Enhanced flexibility
- ✔ Higher mechanical toughness
- ✔ Increased melt strength
- ✔ Enables film blowing with PHB
- ✔ Improved processability

Origin and Availability

In contrast to the indirect production of PLA, PHA/PHB polymer is produced directly via fermentation of renewable raw materials, such as sugars and starches.

Classification: Home Compostable

PHA/PHB will degrade in typical home composting and industrial composting, as well as in water environments.

Properties

The properties of PHAs are quite promising. They offer a wide scope of mechanical properties ranging from stiff like polypropylene to flexible like plasticized PVC. Additionally, they offer a relatively high heat resistance of up to over 150 °C (Vicat A) of PHB.

Typical Applications

This recommends PHA and PHB for e.g.:

- Cutlery
- Packaging (boxes, bags, foams)
- Mulch films
- Personal care (razors, tooth brush handles)
- Office supplies (pens)
- Golf pins
- Toys
- Household wares

Market Possibilities

PHA/PHB has high potential.
It can be used in:

- Injection molding
- Blow molding

VINNEX® improves the processing window of PHA/PHB. VINNEX® makes it possible to process PHB by film blowing, thus enlarging its application spectrum.

VINNEX® AND PHA/PHB: NEW MARKET POSSIBILITIES

When using blends of PHA/PHB with VINNEX®, the processing speed and processability are almost comparable to standard thermoplastics.

Optimized Crystallinity

VINNEX® increases the crystallization speed of PHB and reduces the size of spherulites, thus positively affecting processability. Furthermore, it reduces the tendency to recrystallize and therefore prevents brittleness.

Lower Melting Point

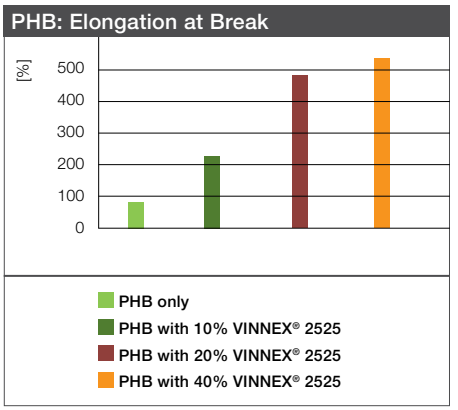
VINNEX® resins reduce the blend's melting point and widen the processing temperature window.

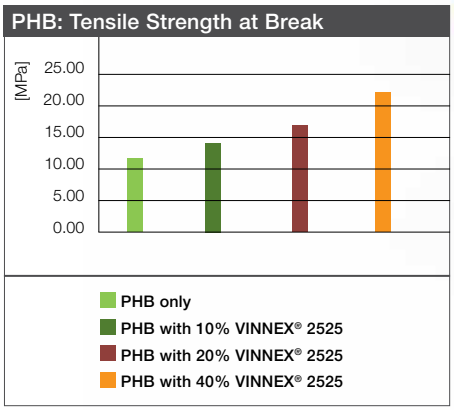
Improved Toughness

Depending on the use level, VINNEX® improves elongation at break and, at the same time, tensile strength at break (see graphs).

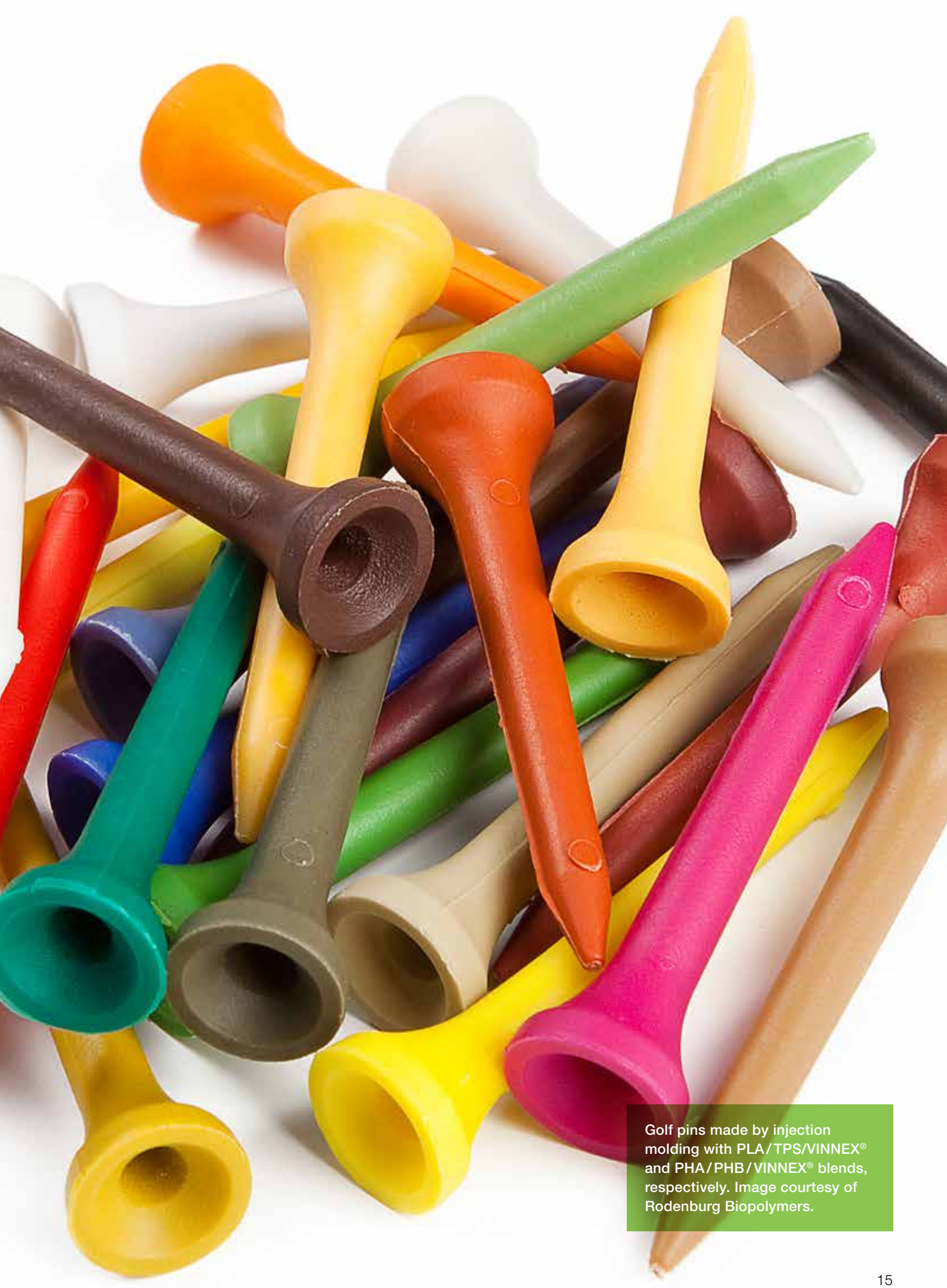
Miscibility of VINNEX® Blends

DSC analysis shows a single glass transition for all VINNEX® resin blend compositions, indicating that VINNEX® resins form miscible blends with PHA and PHB.





VINNEX® improves toughness of PHB blends.



Golf pins made by injection molding with PLA/TPS/VINNEX® and PHA/PHB/VINNEX® blends, respectively. Image courtesy of Rodenburg Biopolymers.

VINNEX® AND PBS(A): A PERFECT ALTERNATIVE

Polybutylene succinates PBS(A) are produced from 1,4-butanediol (1,4-BDO) and succinic acid (SA), frequently in combination with a third monomer, e.g., adipic acid (AA) (PBSA). They offer superior biodegradability and display mechanical characteristics similar to classic polyolefins. PBS and its derivates can be processed via injection or extrusion to manufacture fibers, laminates, films or sheets.

Profile of PBS

Advantages

- Good heat sealability
- High suitability for paper coating
- Good printability
- Good processability in injection molding
- High heat resistance
- Low processing temperatures possible
- Excellent biodegradability

Profile of PBS/VINNEX® Blends

With VINNEX® Powder

- Improved compatibility with polar fillers
- Improved compatibility with other biopolymers
- Enhanced flexibility
- Improved processability in extrusion
- Improved processability in thermoforming

With VINNEX® Resin

- Enhanced flexibility
- No reduction of hardness
- No reduction of modulus
- Increased melt strength
- Improved tear resistance
- Improved crystallization control

Origin and Availability

PBS can be fossil or bio-based. Succinic acid and 1,4-butanediol are already available as bio-based monomers.*

Classification: Biodegradable in Soil

PBS is decomposed by microorganisms in soil. The decomposition rate is more rapid than that of PLA.

Market Possibilities

PBS can be used in:

- Injection molding
- Sheet extrusion

VINNEX® enables thermoforming of PBS blends. It reduces recrystallization tendencies, improves compatability with other biopolymers (e.g. PLA) and increases stiffness.

Typical Applications

PBS is typically used for:

- Medical applications
- Disposable tableware and cups
- Compostable bags
- Agricultural mulch film
- Nonwoven fabric

* Source: Bio-Based Building Blocks and Polymers – Global Capacities and Trends 2018-2023

Compostable bag made out of PLA / TPS / VINNEX® blends.

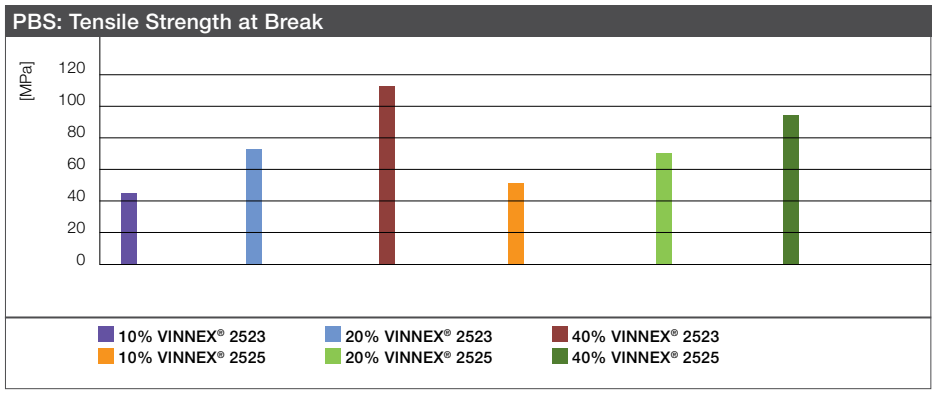
VINNEX® AND PBS:
A PERFECT MATCH

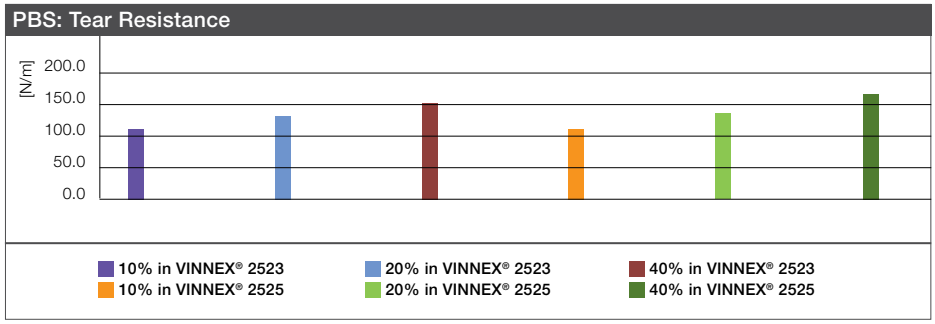
VINNEX® enables new applications for PBS, such as thermoforming. VINNEX® reduces recrystallization tendencies and improves the compatibility of PBS with other biopolymers.

Improved Properties
VINNEX® reduces recrystallization tendencies and therefore keeps initial properties constant. In addition, it enables the production of highly filled blends with organic and inorganic fillers.

Improved Flexibility
Depending on the use level, VINNEX® helps improve flexibility. But it can also enable extra stiffness when blended with PLA. VINNEX® resins improve tear resistance of PBS blends.

Excellent Thermoforming Properties
VINNEX® enables PBS/PLA blends to be used in thermoforming applications by improving compatibility and melt strength.





Achievable mechanical properties with PBS/VINNEX® resin blends for injection molding and thermoforming.

Compared to a regular PBS/PLA blend with chalk (picture on the left), the addition of VINNEX® powder enables proper thermoforming (picture on the right).

VINNEX® AND GENIOPLAST®: ENHANCING BIOPOLYESTER PROPERTIES

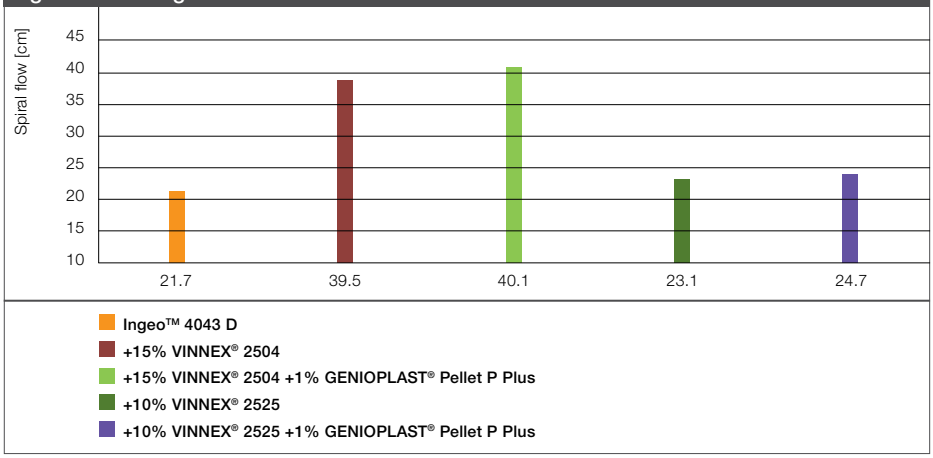
Biodegradable polymers such as polylactic acid (PLA), polyhydroxyalkanoates (PHA), polybutylene succinate (PBS), polybutylene adipate terephthalate (PBAT) or thermoplastic starch (TPS) are already widely used as alternatives to conventional plastics. But the processing and properties of these biodegradable polymers are challenging and not always ideal.

Our carbon and silicone-based additives help to unleash the potential of biodegradable plastics and are presently well established in the market. What is so special about our carbon and silicone-based additives are their recently discovered synergistic effects. Through these synergistic effects, biodegradable plastics are processed in a similar way to standard thermoplastics on conventional plastics processing machinery, with significant improvements in mechanical and surface properties.

Utilizing the Synergy between VINNEX® and GENIOPLAST®

Carbon-based VINNEX® additives consist of copolymers of vinyl acetate and long-chain esters. These additives act as compatibilizers for various biopolyesters and fillers and enhance the final material's flexibility, softness, impact resistance and processing. VINNEX® lowers the viscosity of the melt while simultaneously increasing melt strength.
Silicone-based GENIOPLAST® additives consist of UHMW siloxane and silica. The additives impart a lower extruder torque, lower the pressure of form printing and pressure casting, and increase throughput. They improve the material's surface properties, for example reducing coefficient of friction, improving scratch resistance and imparting a softer touch.

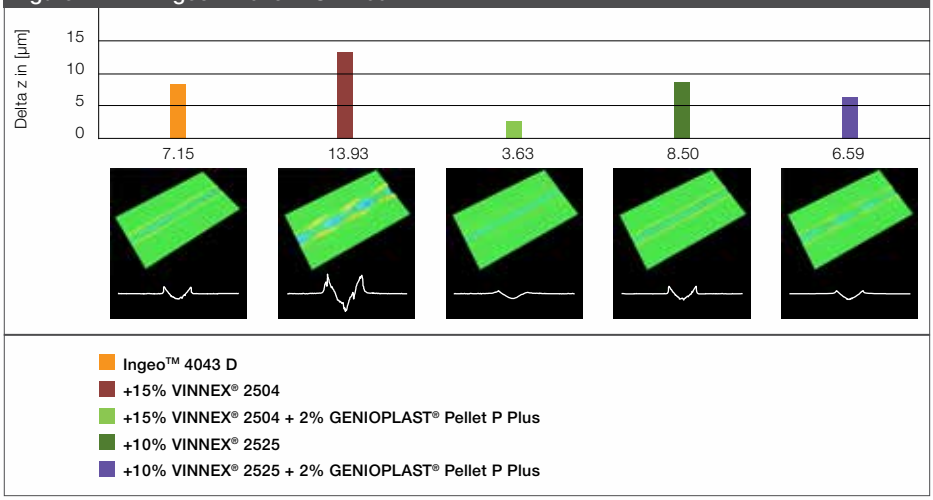
Figure 1: PLA Ingeo™ 4043 D Unfilled



Spiral flow detected with PLA Ingeo™ 4043 D unfilled, and compounds with VINNEX® 2504 (polyvinyl acetate/ethylene) and GENIOPLAST® Pellet P (silicone) or VINNEX® 2525 (polyvinyl acetate) and GENIOPLAST® Pellet P (silicone).

The synergistic effects of carbon and silicone-based additive combinations were evaluated using PLA and PBS compounds with and without fillers. Figure 1 shows the positive effect of polyvinyl acetate polymers (VINNEX®) on the melt flow of PLA and the further improvement by adding silicone (GENIOPLAST®).

Figure 2: PLA Ingeo™ 4043 D Unfilled



Scratch depth, determined by confocal microscopy including PLA Ingeo™ 4043 D unfilled and compounds with VINNEX® 2504 (polyvinyl acetate/ethylene) plus GENIOPLAST® Pellet P (silicone) or VINNEX® 2525 (polyvinyl acetate) and GENIOPLAST® Pellet P (silicone).

The addition of polyvinyl acetate to PLA usually reduces the scratch resistance of polymer surfaces, which can be improved by adding silicone, as shown in Figure 2.

APPLICATIONS AND TECHNOLOGIES OF VINNEX® ADDITIVES

Recommendation According to Biopolymer											
	Product	**Polymer Composition**	**Transparency**	**Tg [°C]**	**PLA**	**PLA/Starch**	**PHA**	**PHA/PLA**	**PHA/PLA/Starch**	**PBS**	**PBS/PLA**	**PBS/PLA/Starch**
Powders												
	VINNEX® 2501	VAc-E	Opaque	16	●	●	○	●	●	●	●	●
	VINNEX® 2502	VAc-E	Opaque	10	●	●	●	●	●	●	●	●
	VINNEX® 2504	VAc-E	Opaque	-7	●	●	●	●	●	●	●	●
	VINNEX® 2505	VAc-VV-E	Opaque	-14	●	●	●	●	●	●	●	●
Resins												
	VINNEX® 2522	VAc	Transparent	42	●	●	●	●	●	●	●	●
	VINNEX® 2523	VAc	Transparent	43	●	●	●	○	○	●	○	○
	VINNEX® 2525	VAc	Transparent	44	●	●	●	○	○	●	○	○
	VINNEX® 2526	VAc	Transparent	44	●	●	●	●	●	●	●	●
	VINNEX® 8802	VAc-VL	Transparent	25	●	●	●	●	●	●	●	●
	VINNEX® 8803	VAc-VL	Transparent	25	●	●	○	○	●	●	●	●
	VINNEX® 8880	VAc-VL	Transparent	21	●	●	●	●	●	●	●	●

Recommendation According to Processing									
	Product	**Polymer Composition**	**Particle Nature**	**MFR**	**Extrusion**	**Injection Molding**	**Calendering**	**Blown Film Extrusion**	**Thermoforming**
Powders									
	VINNEX® 2501	VAc-E	Powder	4.3	●	●	○	○	○
	VINNEX® 2502	VAc-E	Powder	3.1	●	●	●	○	○
	VINNEX® 2504	VAc-E	Powder	2.1	●	●	●	●	●
	VINNEX® 2505	VAc-VV-E	Powder	6.1	●	●	○	●	●
Resins									
	VINNEX® 2522	VAc	Pellets	26 ***	●	●	○	○	○
	VINNEX® 2523	VAc	Beads	7.0*	●	●	○	●	○
	VINNEX® 2525	VAc	Beads	15.4	●	○	●	●	●
	VINNEX® 2526	VAc	Beads	N.m.	●	○	●	●	●
	VINNEX® 8802	VAc-VL	Pellets	11.4**	○	●	○	○	○
	VINNEX® 8803	VAc-VL	Pellets	3 **	●	●	○	○	○
	VINNEX® 8880	VAc-VL	Pellets	46.6**	●	●	○	●	●

Recommendation According to Application****										
	Product	**Polymer Composition**	**Transparency**	**Agro**	**Consumer**	**Food**	**Medical**	**Packaging**	**Adhesives**	**Coating**
Powders										
	VINNEX® 2501	VAc-E	Opaque	●	●	●	●	●	○	–
	VINNEX® 2502	VAc-E	Opaque	●	●	●	●	●	○	–
	VINNEX® 2504	VAc-E	Opaque	●	●	●	●	●	●	–
	VINNEX® 2505	VAc-VV-E	Opaque	●	●	–	–	○	●	–
Resins										
	VINNEX® 2522	VAc	Transparent	○	●	●	○	●	●	●
	VINNEX® 2523	VAc	Transparent	●	●	●	●	●	●	●
	VINNEX® 2525	VAc	Transparent	●	●	●	●	●	●	●
	VINNEX® 2526	VAc	Transparent	●	●	●	○	●	●	●
	VINNEX® 8802	VAc-VL	Transparent	●	●	○	○	○	○	○
	VINNEX® 8803	VAc-VL	Transparent	○	●	○	○	●	●	●
	VINNEX® 8880	VAc-VL	Transparent	●	●	○	○	●	○	○

● Main application
○ Secondary application
– Not recommended

VAc = Vinyl acetate
E = Ethylene
VAc-E = Vinyl acetate-ethylene copolymer
VV = Vinyl versatate
VAc-VL = Vinyl acetate-vinyl laurate copolymer

VL = Vinyl laurate
Mw = Molecular weight
N.m. = Not measurable
Tg = Glass transition temperature

MFR = Melt index [cm^3/10 min] measured at 150 °C/21.6 kg/2 mm
* Measured at 150 °C/2.16 kg/2 mm
** Measured at 100 °C/2.16 kg/2 mm
*** Measured at 100 °C/21.6 kg/2 mm

**** For most VINNEX® grades food contact information for regulations such as FDA, BfR etc. is available. Please contact your WACKER representative regarding specific clearances.

TECHNICAL PROPERTIES OF VINNEX® ADDITIVES

Characteristics		VINNEX® 2501	VINNEX® 2502	VINNEX® 2504	VINNEX® 2505	VINNEX® 2522	VINNEX® 2523	VINNEX® 2525	VINNEX® 2526	VINNEX® 8802	VINNEX® 8803	VINNEX® 8880
Product description		VAc-E	VAc-E	VAc-E	VAc-VV-E	VAc	VAc	VAc	VAc	VAc-VL	VAc-VL	VAc-VL
Properties		Semi-rigid	Semi-rigid	Flexible	Highly flexible	Rigid	Rigid	Rigid	Rigid	Soft	Soft	Soft
Tg	[°C]	16	10	-7	-14	42	43	44	44	25	25	21
Density	[kg/m³]	1,280	1,270	1,230	1,008	1,18	1,180	1,180	1,18	1,130		1,120
Particle size	[> 400 µm]	Max. 4%	Max. 4%	Max. 4%	Max. 4%	Pellets	Beads	Beads	Beads	Pellets	Pellets	Pellets
Bulk density	[kg/m³]	490 – 590	450 – 550	400 – 550	360 – 460	730	700 – 850	700 – 850	700 – 850	700 – 800		700 – 800
Ash content	[%]	9 – 13	6 – 9	8 – 12	6 – 9	0.01 – 0.05	0.10 – 0.20	0.20 – 0.30	0.20 – 0.30	0.70 – 0.90	0.90 – 1.10	0.30 – 0.50
Molecular weight	[Mw]	N.m.	N.m.	N.m.	N.m.	65,000	110,000 – 150,000	330,000 – 430,000	460,000			
MFR index	[cm³/10 min]	4.3	3.1	2.1	6.1	26 ***	7.0*	15.4	N.m.	11.4 **	3 **	46.6**
Charpy impact ISO 179/1eU	[kJ/m²]	N.m.	N.m.	N.m.	N.m.	N.m.	13.5	12		N.m.		N.m.
Storage temperature	[°C]	< 30	< 30	< 30	< 25	< 20	< 20	< 20		< 10		< 15
Capillary Viscometer 30 x 2 mm Viscosity		**[Pas]**										
110 °C	1	[1/s]	24,188	24,188	21,564	13,235	N.m.	7,530	20,309		228		144
	100	[1/s]	4,959	4,389	4,196	2,782	1,174	2,064	3,705	3,796	211	641	106
	1,000	[1/s]	987	819	724	530	370	433	699	559	108	232	61
130 °C	1	[1/s]	15,517	16,658	14,604	8,671		2,510	12,322		N.m.		122
	100	[1/s]	3,033	3,055	2,987	1,961	382	923	2,223	2,163	68	182	58
	1,000	[1/s]	625	593	557	398	146	235	393	358	39	76	22
150 °C	1	[1/s]	10,383	11,980	10,839	6,503		N.m.	7,530		N.m.		110
	100	[1/s]	2,109	2,269	2,155	1,414	125	N.m.	1,539	1,599	41	N.m.	37
	1,000	[1/s]	429	435	438	326	68	N.m.	262	251	17	N.m.	3
170 °C	1	[1/s]	7,074	9,013	9,127	5,020		N.m.	4,678		N.m.		104
	100	[1/s]	1,608	1,927	1,915	1,163	N.m.	N.m.	1,151	1,100	N.m.	N.m.	35
	1,000	[1/s]	328	365	375	271	N.m.	N.m.	207	193	N.m.	N.m.	3
190 °C	1	[1/s]	5,933	7,758	7,758	4,564		N.m.	2,852		N.m.		5
	100	[1/s]	1,277	1,619	1,585	1,140	N.m.	N.m.	798	1,020	N.m.	N.m.	2
	1,000	[1/s]	268	310	310	213	N.m.	N.m.	160	185	N.m.	N.m.	N.m.
Young's modulus (DIN EN ISO 527) 1 mm/min		[MPa]	N.m.	N.m.	N.m.	N.m.	3,070	2,586	2,998	3,490		4,07	N.m.
Young's modulus (DIN EN ISO 527) 200 mm/min		[MPa]	2.18	0.63	0.11	0.05							N.m.
Elongation at break (DIN EN ISO 527)		[%]	345	326	498	1,289	0.6	2.84	6.55	1.19		308	N.m.
Tensile strength (DIN EN ISO 527)		[MPa]	12.89	11.29	5.56	1.86	13.3	36.60	33.96	51		6.12	N.m.

VAc = Vinyl acetate
E = Ethylene
VAc-E = Vinyl acetate-ethylene copolymer
VV = Vinyl versatate

VAc-VL = Vinyl acetate-vinyl laurate copolymer
VL = Vinyl laurate
Mw = Molecular weight
N.m. = Not measurable

MFR = Melt index [cm³/10 min] measured at 150 °C/21.6 kg/2 mm
* Measured at 150 °C/2.16 kg/2 mm
** Measured at 100 °C/2.16 kg/2 mm
*** Measured at 100 °C/21.6 kg/2 mm

TECHNICAL PROPERTIES OF VINNEX® BLENDS

Characteristics		VINNEX® LA 2540	VINNEX® LA 2640	VINNEX® LA 8040
Product description		PLA/VAc	PLA/VAc	PLA/VAc-VL
Delivery form		Pellets	Pellets	Pellets
Properties		Rigid	Rigid	Rigid
Tg	[°C]	51.5	52	50
Density	[kg/m^3]	1,23	1,23	1,22
Particle size	[mm]	2 – 4	2 – 4	1 – 3
Bulk density	[kg/m^3]	650 – 750	650 – 750	650 – 750
Ash content	[%]	0.01 – 0.2	0.01 – 0.2	0.01 – 0.2
MFR index (170 °C / 10 kg / 2 mm)	[cm^3/10 min]	7 – 8	4.5 – 5.5	
MFR index (170 °C / 2.16 kg / 2 mm)	[cm^3/10 min]			9.5 – 10.5
Charpy impact	[kJ/m^2]	17	17	18
Storage temperature	[°C]	< 30	< 30	< 30
Capillary viscometer 30 x 2 mm (170 °C)	100/s [Pa.s]	1,890	2,220	400
Tensile strength (DIN EN ISO 527)	[MPa]	57.2	51.9	41.1
Elongation at break (DIN EN ISO 527)	[%]	2.4	2.3	2.6
Young's modulus (DIN EN ISO 527) 1 mm/min	[MPa]	3,260	2,940	1,670

PLA with VINNEX® LA 8040

PLA with VINNEX® LA 2540

PLA with VINNEX® LA 2640

EXPERTISE AND SERVICE NETWORK ON FIVE CONTINENTS

Sales offices, production sites and technical competence centers around the world.

WACKER is one of the world's leading and most research-intensive chemical companies, with total sales of €8.2bn. Products range from silicones, binders and polymer additives for diverse industrial sectors to bioengineered pharmaceutical actives and hyperpure silicon for semiconductor and solar applications. As a technology leader focusing on sustainability, WACKER promotes products and ideas that offer a high value-added potential to ensure that current and future generations enjoy a better quality of life, based on energy efficiency and protection of the climate and environment.

Spanning the globe with 4 business divisions, we offer our customers highly-specialized products and comprehensive service via 27 production sites, 25 technical competence centers, 13 WACKER ACADEMY training centers and 47 sales offices in Europe, North and South America, and Asia – including a presence in China. With a workforce of some 15,700, we see ourselves as a reliable innovation partner that develops trailblazing solutions for, and in collaboration with, our customers. We also help them boost their own success. Our technical competence centers employ local specialists, who assist customers worldwide in the development of products tailored to regional demands, supporting them during every stage of their complex production processes, if required.

WACKER e-solutions are online services provided via our customer portal and as integrated process solutions. Our customers and business partners thus benefit from reliable service and comprehensive information to enable projects and orders to be handled fast, reliably and highly efficiently.

Visit us anywhere, anytime around the world at: **www.wacker.com**

All figures are based on fiscal 2022.

WACKER

Wacker Chemie AG
Hanns-Seidel-Platz 4
81737 Munich, Germany
www.wacker.com/contact

www.wacker.com

Follow us on:

7002en

7002en/03.24 replaces7002e/09.22