ADDITIVES FOR BIOPOLYMERS

VINNEX® – ENABLING THE NEXT GENERATION OF BIOPLASTICS
Experts estimate that 90% of the polymers (including fibers) consumed worldwide\(^1\) could be substituted by biobased polymers. It is also expected that the production of these biopolymers will grow by over 30% per year\(^2\). VINNEX\(^\circledR\) helps you to realize this potential: VINNEX\(^\circledR\) enables biopolyesters and starches to be used in new applications with customized properties. Thus VINNEX\(^\circledR\) blends can be processed on unmodified thermoplastic equipment.

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1 Shen et al. “Product overview and market projection of emerging bio-based plastics” PRO-BIP 2009
2 European Bioplastics/Institute for Bioplastics and Biocomposites, October 2012
BIOPLASTICS HAVE A GREAT FUTURE. LET’S ENABLE IT TODAY.

In the plastic world, there is no doubt that the strong dependency on petroleum has to be diminished. Accordingly, 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

Vincotte, a globally recognized certification body, has introduced a nomenclature which makes it easier to recognize the ecological impact of so-called biopolymers. The differentiation between biobased, compostable and biodegradable polymers is especially relevant.

Biobased Polymers

Biobased polymers consist to a certain extent of biomass. The amount is declared via stars:

- ✱: between 20 and 40% biobased
- ✱✱: between 40 and 60% biobased
- ✱✱✱: between 60 and 80% biobased
- ✱✱✱✱: more than 80% biobased

Compostable and Biodegradable Polymers

Compostable and biodegradable polymers must be degradable by microorganisms, but they are not necessarily biobased. 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. In both cases, it is not guaranteed that the process will result in good quality compost.
- Biodegradable in soil: polymer will completely biodegrade in the soil without adversely affecting the environment.
- Biodegradable in water: polymer will biodegrade in a natural fresh water environment without adversely affecting it. This does not necessarily apply to marine water.
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 30%, 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 the combination of different biopolymer raw materials, 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

<table>
<thead>
<tr>
<th>Blend with:</th>
<th>VINNEX® Powder</th>
<th>VINNEX® Resin</th>
</tr>
</thead>
</table>
| 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 representative 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.

Profile of PLA

Advantages:
- High gloss
- High stiffness
- Good mechanical properties
- High transparency

Profile of PLA/VINNEX® Blends

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
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).

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).

Highly transparent shrink films are made from a PLA/VINNEX® resin blend. Images courtesy of Moel.
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 20 – 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.

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

Compared to pure PLA (picture on the left), the PLA/VINNEX® 2525 blend (picture on the right) exhibits improved 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.

### 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.
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.
Plastic bowl and golf pins made by injection molding with PLA/TPS/VINNEX® and PHA/PHB/VINNEX® blends, respectively. Image courtesy of Rodenburg Biopolymers.
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.
Polybutylene succinate (PBS) is produced from succinic acid and 1,4-butanediol. It is soil degradable and displays mechanical properties similar to classical polyolefins. It can be processed via injection or extrusion to manufacture fibers, laminates, films or sheets.

### Origin and Availability

Today, PBS is not biobased. Still, it is expected that, in the near future, all raw materials for PBS will be produced via fermentation, so that a completely bio-based PBS will be available.

### 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

### 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

### With VINNEX® Powder:

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

### With VINNEX® Resin:

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

### Profile of PBS

### Profile of PBS/VINNEX® Blends
Business card box and gift card made out of PLA/TPS/VINNEX® blends. Image courtesy of Rodenburg Biopolymers.
PBS/PLA/VNNEX® blends have improved stiffness without affecting biodegradability. This makes them suitable e.g. for disposable cutlery.
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.

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**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).**
### Recommendation According to Biopolymer

<table>
<thead>
<tr>
<th>Product</th>
<th>Polymer Composition</th>
<th>Transparency</th>
<th>Tg [°C]</th>
<th>PLA</th>
<th>PLA/ Starch</th>
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### Recommendation According to Processing

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### Recommendation According to Application****

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**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 (ccm/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
### Recommendation According to Biopolymer Product Polymer Composition

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<thead>
<tr>
<th>Transparency</th>
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- **Powders**
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  - 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

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- **Powders**
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  - 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 Granules: 7.0 *
  - VINNEX® 2525 VAc Granules: 15.4
  - VINNEX® 2526 VAc Pellets: n.m.
  - VINNEX® 8802 VAc VL Granules: 11.4 **
  - VINNEX® 8803 VAc VL Beads: 3 **
  - VINNEX® 8880 VAc VL Granules: 46.6 **

### Recommendation According to Application Product Polymer Composition

<table>
<thead>
<tr>
<th>Transparency</th>
<th>Agro</th>
<th>Consumer</th>
<th>Food</th>
<th>Medical</th>
<th>Packaging</th>
<th>Adhesives</th>
<th>Coating</th>
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<td>Tg = Glass transition temperature</td>
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- **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

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Delicate 3D objects made out of PLA/TPS/ VINNEX® blends. Image courtesy of Rodenburg Biopolymers.

Containers made by injection molding using a PLA/TPS/VINNEX® blend. Image courtesy of Biotec.

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

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>VINNEX® 2501</th>
<th>VINNEX® 2502</th>
<th>VINNEX® 2504</th>
<th>VINNEX® 2505</th>
</tr>
</thead>
<tbody>
<tr>
<td>Product description</td>
<td>VAc-E</td>
<td>VAc-E</td>
<td>VAc-E</td>
<td>VAc-VV-E</td>
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<tr>
<td>Properties</td>
<td>Semi-rigid</td>
<td>Semi-rigid</td>
<td>Flexible</td>
<td>Highly flexible</td>
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<tr>
<td>Tg [°C]</td>
<td>16</td>
<td>10</td>
<td>-7</td>
<td>-14</td>
</tr>
<tr>
<td>Density [kg/m³]</td>
<td>1,280</td>
<td>1,270</td>
<td>1,230</td>
<td>1,008</td>
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<tr>
<td>Particle size (&gt; 400 μm)</td>
<td>Max. 4%</td>
<td>Max. 4%</td>
<td>Max. 4%</td>
<td>Max. 4%</td>
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<tr>
<td>Bulk density [kg/m³]</td>
<td>490 – 590</td>
<td>450 – 550</td>
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<td>Ash content [%]</td>
<td>9 – 13</td>
<td>6 – 9</td>
<td>8 – 12</td>
<td>6 – 9</td>
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<td>Molecular weight [Mw]</td>
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<td>n.m.</td>
<td>n.m.</td>
<td>n.m.</td>
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<td>MFR melt index [ccm/10 min]</td>
<td>4.3</td>
<td>3.1</td>
<td>2.1</td>
<td>6.1</td>
</tr>
<tr>
<td>Charpy impact ISO 179/1eU [kJ/m²]</td>
<td>n.m.</td>
<td>n.m.</td>
<td>n.m.</td>
<td>n.m.</td>
</tr>
<tr>
<td>Storage temperature [°C]</td>
<td>&lt; 30</td>
<td>&lt; 30</td>
<td>&lt; 30</td>
<td>&lt; 25</td>
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### Capillary Viscosity 30 x 2 mm Viscosity [Pas]

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<thead>
<tr>
<th></th>
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<th></th>
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<tbody>
<tr>
<td>110 °C</td>
<td>1</td>
<td>24,188</td>
<td>24,188</td>
<td>21,564</td>
<td>13,235</td>
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<tr>
<td>100</td>
<td>4,959</td>
<td>4,389</td>
<td>4,196</td>
<td>2,782</td>
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<tr>
<td>1,000</td>
<td>987</td>
<td>819</td>
<td>724</td>
<td>530</td>
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<tr>
<td>130 °C</td>
<td>1</td>
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<td>16,658</td>
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<td>8,671</td>
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<td>100</td>
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<td>557</td>
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<td>11,980</td>
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<td>6,503</td>
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<td>2,109</td>
<td>2,269</td>
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<td>435</td>
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<td>7,074</td>
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<tr>
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<td>1,927</td>
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<td>328</td>
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<td>375</td>
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<td>7,758</td>
<td>7,758</td>
<td>4,564</td>
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<td>1,619</td>
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<td>310</td>
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<tr>
<td>Young’s modulus (DIN EN ISO 527) 1 mm/min [MPa]</td>
<td>n.m.</td>
<td>n.m.</td>
<td>n.m.</td>
<td>n.m.</td>
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<tr>
<td>Young’s modulus (DIN EN ISO 527) 200 mm/min [MPa]</td>
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<tr>
<td>Elongation at break (DIN EN ISO 527) [%]</td>
<td>345</td>
<td>326</td>
<td>498</td>
<td>1,289</td>
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</tr>
<tr>
<td>Tensile strength (DIN EN ISO 527) [MPa]</td>
<td>12.89</td>
<td>11.29</td>
<td>5.56</td>
<td>1.86</td>
<td></td>
</tr>
</tbody>
</table>

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 [ccm/10 min] measured at 150°C/2.16 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
<table>
<thead>
<tr>
<th>Characteristics</th>
<th>VINNEX® 2501</th>
<th>VINNEX® 2502</th>
<th>VINNEX® 2504</th>
<th>VINNEX® 2505</th>
<th>VINNEX® 2522</th>
<th>VINNEX® 2523</th>
<th>VINNEX® 8802</th>
<th>VINNEX® 8803</th>
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<tbody>
<tr>
<td>Product description</td>
<td>VAc</td>
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<td>VAc</td>
<td>VAc-VV-E</td>
<td>VAc</td>
<td>VAc</td>
<td>VAc-VL</td>
<td>VAc-VL</td>
<td>VAc-VL</td>
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<tr>
<td>Properties</td>
<td>Semi-rigid</td>
<td>Semi-rigid</td>
<td>Flexible</td>
<td>Highly flexible</td>
<td>Rigid</td>
<td>Rigid</td>
<td>Soft</td>
<td>Soft</td>
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<tr>
<td>Tg [°C]</td>
<td>16</td>
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<td>-7</td>
<td>-14</td>
<td>42</td>
<td>43</td>
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<td>Density [kg/m³]</td>
<td>1,280</td>
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<td>1,18</td>
<td>1,18</td>
<td>1,180</td>
<td>1,180</td>
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<tr>
<td>Particle size [&gt; 400 μm]</td>
<td>Max. 4%</td>
<td>Max. 4%</td>
<td>Max. 4%</td>
<td>Max. 4%</td>
<td>Pellets</td>
<td>Beads</td>
<td>Pellets</td>
<td>Beads</td>
<td>Beads</td>
</tr>
<tr>
<td>Ash content [%]</td>
<td>9 – 13</td>
<td>6 – 9</td>
<td>8 – 12</td>
<td>6 – 9</td>
<td>0.01 – 0.05</td>
<td>0.10 – 0.20</td>
<td>0.20 – 0.30</td>
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<td>n.m.</td>
<td>n.m.</td>
<td>65,000</td>
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<td>330,000 – 430,000</td>
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<tr>
<td>MFR melt index [ccm/10 min]</td>
<td>4.3</td>
<td>3.1</td>
<td>2.1</td>
<td>6.1</td>
<td>26 **</td>
<td>7.0*</td>
<td>3 **</td>
<td>46.6**</td>
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<td>Charpy impact ISO 179/1eU [kJ/m²]</td>
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<td>n.m.</td>
<td>n.m.</td>
<td>13.5</td>
<td>12</td>
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<tr>
<td>Storage temperature [°C]</td>
<td>&lt; 30</td>
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<td>&lt; 30</td>
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<td>&lt; 20</td>
<td>&lt; 20</td>
<td>&lt; 20</td>
<td>&lt; 20</td>
<td>&lt; 20</td>
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<tr>
<td>Capillary Viscometer 30 x 2 mm Viscosity [Pas]</td>
<td>110 °C</td>
<td>1  [1/s]</td>
<td>24,188</td>
<td>24,188</td>
<td>n.m.</td>
<td>7,530</td>
<td>20,309</td>
<td>228</td>
<td>144</td>
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<tr>
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<td>1  [1/s]</td>
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<td>4,389</td>
<td>n.m.</td>
<td>2,510</td>
<td>3,033</td>
<td>2,109</td>
<td>106</td>
</tr>
<tr>
<td></td>
<td>1,000</td>
<td>1  [1/s]</td>
<td>987</td>
<td>819</td>
<td>n.m.</td>
<td>625</td>
<td>625</td>
<td>625</td>
<td>106</td>
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<tr>
<td></td>
<td>130 °C</td>
<td>1  [1/s]</td>
<td>10,383</td>
<td>11,980</td>
<td>n.m.</td>
<td>10,383</td>
<td>13,5</td>
<td>13,5</td>
<td>13,5</td>
</tr>
<tr>
<td></td>
<td>190 °C</td>
<td>1  [1/s]</td>
<td>7,074</td>
<td>9,013</td>
<td>n.m.</td>
<td>7,074</td>
<td>12 n.m.</td>
<td>12 n.m.</td>
<td>12 n.m.</td>
</tr>
<tr>
<td></td>
<td>150 °C</td>
<td>1  [1/s]</td>
<td>5,933</td>
<td>7,758</td>
<td>n.m.</td>
<td>5,933</td>
<td>n.m.</td>
<td>n.m.</td>
<td>n.m.</td>
</tr>
<tr>
<td></td>
<td>170 °C</td>
<td>1  [1/s]</td>
<td>5,933</td>
<td>7,758</td>
<td>n.m.</td>
<td>5,933</td>
<td>n.m.</td>
<td>n.m.</td>
<td>n.m.</td>
</tr>
<tr>
<td></td>
<td>190 °C</td>
<td>1  [1/s]</td>
<td>5,933</td>
<td>7,758</td>
<td>n.m.</td>
<td>5,933</td>
<td>n.m.</td>
<td>n.m.</td>
<td>n.m.</td>
</tr>
<tr>
<td>Young's modulus (DIN EN ISO 527) 1 mm/min [MPa]</td>
<td>n.m.</td>
<td>n.m.</td>
<td>n.m.</td>
<td>n.m.</td>
<td>3,070</td>
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<td>2,998</td>
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<td>n.m.</td>
<td>n.m.</td>
<td>n.m.</td>
<td>n.m.</td>
<td>n.m.</td>
<td>n.m.</td>
<td>n.m.</td>
</tr>
<tr>
<td>Elongation at break (DIN EN ISO 527) [%]</td>
<td>345</td>
<td>326</td>
<td>498</td>
<td>1,289</td>
<td>0,6</td>
<td>2.84</td>
<td>6.55</td>
<td>1.19</td>
<td>308</td>
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<td>11.29</td>
<td>5.56</td>
<td>1.86</td>
<td>13.3</td>
<td>36.60</td>
<td>33.96</td>
<td>51</td>
<td>6.12</td>
</tr>
</tbody>
</table>

Thermoformed biodegradable flower pots made out of a cellulose-acetate/VINNEX® blend. Image courtesy of Biofibre.
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All figures are based on fiscal 2018.
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Phone: +49 89 6279-0
info@wacker.com
www.wacker.com
www.wacker.com/socialmedia

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