FDCA bioplastics
BIIOBASED MONOMERS FOR PEF

corbion.com/bioplastics
Why bioplastics?

**More planet friendly**
Bioplastics are made from renewable, biobased resources, providing a more sustainable alternative to traditional oil-based plastics.

**Rapidly growing profitable business opportunity**
Consumers are becoming increasingly aware of their impact on our planet and are starting to appreciate and seek out more environmentally friendly alternatives.

**Favorable CO₂ footprint**
Bioplastics offer a considerably reduced CO₂ footprint when compared with oil-based plastics.

Why FDCA?

**Highly efficient use of feedstocks**
>99% yield for the biocatalytic conversion of the hydroxymethylfurfural (HMF) intermediate to FDCA. PEF produced via the Corbion route offers very high polymer yield per kg of feedstock. In comparison, other types of bioplastics can require significantly more natural resources to produce the same amount of end-product.

**High process flexibility by using raw HMF**
Corbion’s unique and versatile biocatalyst is able to operate on a variety of HMF stream qualities and has demonstrated resistance to impurities. In fact, the micro-organism is able to thrive on impurities present in raw HMF streams. This offers a unique advantage over other HMF to FDCA converting systems, which depend on highly pure HMF.

**High purity**
With a selectivity greater than 99%, Corbion’s process produces polymer grade FDCA with virtually no reaction by-products.

**Low cost solution**
The mild process conditions and high selectivity associated with our bioconversion process, as well as the implementation of our proprietary gypsum-free DSP process, allow for favorable CAPEX and OPEX, requiring smaller economies of scale when compared to oil-based routes.

Why Corbion Purac?

**Advanced technology and R&D**
At Corbion Purac, we engage in ongoing R&D efforts to improve performance and sustainability of our products and processes. The breakthrough in gypsum-free technology and the use of alternative feedstocks are key focus areas for us.

**Consistent high quality**
Corbion Purac has mastered the production technologies required to make high purity, high performance monomers for bioplastics at industrial scale (75 KT lactide plant in Thailand).

**85 years of fermentation experience**
Corbion Purac is the global market leader in lactic acid, lactic acid derivatives and lactides, with over 85 years of fermentation experience with organic acid production.

**Global presence**
With 11 production facilities and sales offices on every continent, we are always close by to help you with your application development.

Introducing FDCA

Corbion Purac has developed a proprietary process to produce 2,5-Furandicarboxylic acid (FDCA) from renewable resources with a reduced carbon footprint. FDCA has the potential to replace purified terephthalic acid (PTA) in a variety of applications. For instance, FDCA can be polymerized into polyethylene furanoate (PEF) making use of existing polyester infrastructure. PEF gives improved finished product performance, due to better barrier, thermal and mechanical properties when compared to PET. At the same time, it improves packaging sustainability, since PEF produced from FDCA is 100% biobased when biobased monoethylene glycol (MEG) is used.
Drop-in and increased performance

FDCA is not a direct replacement for PTA, as PEF is not a direct replacement for PET since their chemical structures are slightly different. However, they are sufficiently similar to allow FDCA to be used in combination with MEG in existing PET polymerization plants, making FDCA an infrastructure drop-in. In a similar manner, PEF can also be used in downstream conversion plants, making it too an infrastructure drop-in. Furthermore, PEF is recyclable which offers converters and brandowners the opportunity of a closed loop product lifecycle. The improved properties of PEF compared to PET offer better performance in existing applications, such as in carbonated soft drink bottles. In addition, PEF opens the door to new applications where PET properties do not suffice, like in smaller serving sizes and lightweighting, and also for replacing other packaging materials like glass and aluminum cans.

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<thead>
<tr>
<th></th>
<th>PEF</th>
<th>PET</th>
<th>Application</th>
</tr>
</thead>
<tbody>
<tr>
<td>Barrier</td>
<td>O₂</td>
<td>6-10 x</td>
<td>O₂ sensitive drinks to eliminate use of O₂ scavenger (e.g., juice, beer)</td>
</tr>
<tr>
<td></td>
<td>CO₂</td>
<td>4-6 x</td>
<td>Carbonated drinks (e.g., smaller serving size)</td>
</tr>
<tr>
<td></td>
<td>H₂O</td>
<td>2 x</td>
<td>Water bottles</td>
</tr>
<tr>
<td>Mechanical</td>
<td>Modulus</td>
<td>1.6</td>
<td>Lighter bottles</td>
</tr>
<tr>
<td>Thermal</td>
<td>T₆ (°C)</td>
<td>86 - 87</td>
<td>Hot fill applications</td>
</tr>
<tr>
<td></td>
<td>T₉ (°C)</td>
<td>213 - 235</td>
<td>Energy reduction for preform production</td>
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FDCA to PEF value chain

Corbion is engaged in the complete value chain from sugars to FDCA and PEF, and works with dedicated partners to further develop and commercialize it (see figure below).

Leveraging 85 years of fermentation and purification experience

Corbion Purac is the global market leader in lactic acid, lactic acid derivatives and lactides, with more than 85 years of experience in lactic acid fermentation and purification. This experience has been leveraged to develop a highly efficient and proprietary bioconversion and gypsum-free purification process to economically produce biobased FDCA for low-cost PEF.
Corbion in bioplastics

For the plastics industry, Corbion Purac offers lactides and PLA resins for general purpose and high performance bioplastics. PLA (Poly Lactic Acid) is a biobased plastic with a low carbon footprint and is used in packaging, disposables, fibers, electronics and automotive markets. Additionally, Corbion is developing 100% biobased FDCA for high performance PEF (Polyethylene Furanate) resin. PEF can, for example, be used for bottle and film applications due to its excellent barrier properties.

About Corbion

Corbion is the global market leader in lactic acid, lactic acid derivatives and lactides, and a leading company in emulsifiers, functional enzyme blends, minerals and vitamins. The company delivers high performance biobased products made from renewable resources and applied in global markets such as bakery, meat, pharmaceuticals and medical devices, home and personal care, packaging, automotive, coatings and coating resins. Corbion operates 11 production plants, in the USA, the Netherlands, Spain, Brazil and Thailand, and markets its products through a worldwide network of sales offices and distributors. In 2014, Corbion generated annual sales of € 770.1 million and had a workforce of 1,893 employees. Corbion is listed on NYSE Euronext Amsterdam.