The East Is Green

Asia's Role in the Commercialization of Bioplastics

Going Green, Going East – Developing more sustainable materials and meeting demand patterns in Asian growth markets are two of today's major challenges for European chemical companies. While Asia will play a critical role in any large-scale commercialization scenario of bioplastics, its regional differences are striking when considering parameters such as feedstock availability, industry infrastructure, customer industries and government policies.

Bioplastics receive an increasing amount of attention by both industry and consumers as one of the main drivers toward a bio-economy. The term bioplastics, however, encompasses a range of polymers that can either be bio-based (at least partially), biodegradable or both. As of today, these materials account for approximately 1.5% of global plastics demand, but it is estimated that they could substitute up to 85% of conventional polymers.

Biodegradable plastics such as starch blends or polylactic acid (PLA) have dominated early bioplastics market development with applications in food packaging, catering products, shopping bags or agriculture. More recently the concept of replacing conventional oil-based plastics such as PE, PP or PET with their bio-based counterparts has gained commercial importance. These "drop-in" solutions focus on durable applications in rigid packaging, health care, consumer goods or automotive sectors and will dominate future capacity additions in the bioplastics industry.

A recent study by Nova Institute forecasts global biopolymer capacities to grow from 3,500 kt in 2011 to approximately 12,000 kt in 2020. New production capacity in Asia alone will be larger than combined additions in the rest of the world. To better understand the drivers behind these projections, it is essential to analyze feedstock availability, industry infrastructure, customer industries and government policies in some of the region's key countries — notably Japan, Thailand and China.


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Japan: R&D Cluster

With its high dependency on oil-based naphtha imports, Japan strives to strategically diversify its raw material supply. Its traditionally strong chemical companies, innovative customer industries and environmentally conscious consumers provide fertile ground for development and launch of bio-based material alternatives. Automotive powerhouse Toyota is on the global forefront in committing to the use of bioplastics in applications such as vent louvers or radiator end tanks.

Chemical industry players Mitsubishi Chemical, Mitsui or Teijin are all engaged in bio-based material research projects. Japan, however, lacks the natural resources and agricultural space to become a bioplastics production center on its own. Large-scale investments of Japanese companies are therefore taking place in feedstock-rich regions of the world. Mitsui has entered a joint venture for bio-PE production with Dow Chemical in Brazil, and Mitsubishi Chemical is constructing a bio-PBS plant with its local partner PTT in Thailand.

Thailand: Production Hub

Other investments in Thailand — like the 75 kt PLA monomer plant of Purac — give evidence of the country's ambitions in becoming the major production hub for bioplastics in Asia. Two competitive advantages stand out: Thailand's big agricultural base as a major global cassava and sugar exporter and supportive government policies addressing strategies, standards and incentives in the National Roadmap for the Development of the Bioplastics Industry.

Thailand also boasts a strong upstream chemical value chain including numerous starch, sugar and glucose plants as well as the largest plastics processing industry in Southeast Asia. In terms of sheer size, however, all eyes are on China.

China: Key Market (To Be ...)

China is the largest plastics processer in the world. Since 2010, its annual plastics consumption is larger than that of all European countries combined. It must play a crucial role in any large-scale commercialization scenario of bioplastics. Current bioplastic capacities in China are yet remarkably small at approximately 300 kt and focus almost entirely on biodegradable materials such as starch, PBS and PLA. Local market demand is at present almost negligible.

But interpreting the ongoing Chinese paradigm shift "from rapid development to more inclusive growth," there are at least three major end-user effects driving the market potential for bioplastics in the country:

- Increasing purchasing power and rising environmental consumer awareness
- More sophisticated, value-added products being manufactured in China
- Proliferation and globalization of Chinese brands.

While the first two points have made Western companies adjust their product portfolios to local demands, the last one is too frequently ignored. Chinese companies such as Huawei, Haier, Lenovo and Geely are becoming truly global brands and increasingly receptive to more innovative technologies. They require dedicated marketing efforts and application support from Western chemical suppliers.

In the light of these developments, SusTech Consult conducted a primary survey among more than 100 plastics processing companies in China to analyze their views on current and future use of bioplastics.

Survey Results

Companies participating in the survey were 75% Chinese entities and 25% Sino-foreign joint ventures from different value chain positions: original equipment manufacturers (OEMs), branded converters and custom molders. Primary focus of the survey was on durable applications.

A first finding: Compared with other aspects of "green plastics" such as hazard-free materials, energy efficiency in production or recycling solutions, bio-based polymers are currently still of low importance to plastics processors in China. Notable exceptions were identified in IT, rigid packaging and consumer goods segments.

Only 5% of companies interviewed had used bioplastics in the past. And if so, mainly for testing or special series purposes. Major reasons for not using bioplastics are high material prices and poor performance properties. Furthermore, a striking 18% of respondents stated that the concept of bioplastics was entirely unknown to them. So besides improving cost/performance issues, a key lever for developing the Chinese bioplastics market is investment in customer education. Looking ahead, the key drivers for bioplastics in China are seen as twofold: A stricter legal framework would push the market in the short- to mid-term, whereas increasing consumer demand and related green strategies of end-users will pull the market in mid- to long-term.

Strategic Implications

Bioplastics in Asia are no low-hanging fruit. While Thailand is on the way to become one of two or three global supply hubs for bioplastics, the Asian demand perspective is significantly more difficult to assess. Educating Asian customers along the value chain on bioplastics is a strategic priority. Within this, evolving global brand owners from China constitute a widely unexplored target group for European bioplastic producers.

For in-depth graphics, please see the article online.

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Products From Plants

Enabling Sustainable Materials with Biosuccinium Succinic Acid

Bio-Based Building Blocks – The need to reduce dependency on fossil resources, a growing world population and an increased concern for the environment are driving companies to supplement oil-based chemicals with plant-based, sustainable, high-quality chemical building blocks.

Reverdia, the joint venture between Royal DSM and Roquette Frères, produces Biosuccinium sustainable succinic acid, with proprietary green technology. It enables customers to produce bio-based, high-quality materials while at the same time substantially improving their environmental footprint.

In December 2012, Reverdia started operations of the world's first large-scale commercial plant for the production of succinic acid from renewable resources. The facility, in Cassano Spinola, Italy, has an annual capacity of about 10,000 tons and is a step in the company's strategy to even larger production facilities in the near future. The location of a second large-scale plant is open, and global opportunities are being evaluated.

Applications

Biosuccinium succinic acid provides impetus for an entire range of more renewable, sustainable bio-based products. While conventional markets for succinic acid include pharmaceuticals, food, coatings and pigments, Reverdia sees that the production of a high-quality, bio-based succinic acid like Biosuccinium helps to drive the emergence of new applications (fig. 1).

An upcoming market is polybutylene succinate (PBS), a biodegradable polymer, for which the market is expected to grow rapidly, partly driven by global policymaking on single-use consumer products. When PBS is based on Biosuccinium, it can have a renewable content as high as 50% and even 100% if bio-based 1,4 butanediol (BDO) also is used. PBS also shows interesting physical properties, like high elongation/flexibility, good temperature resistance and easy processing. It can be applied in a pure form, but it also represents an ideal blend partner in compounds. Copolymerization with different types and content of co-monomers can obtain a range of properties, which provides many opportunities for the packaging industry and the plastics industry in general.

Other applications include those where adipic acid is the current conventional chemical, a large market with many opportunities such as (nonphthalate) plasticizers, coating and composite resins, and polyester polyols for polyurethanes. Biosuccinium improves the bio-based content of these products as well as the carbon and environmental footprint (fig. 2). Biosuccinium has now been produced for several years and has been tested and validated in several of these applications by numerous customers.

Best-in-Class Carbon Footprint and Economics

Reverdia developed and commercialized a unique, proprietary, low pH yeast technology to convert sugars into succinic acid. The novel process is simple, stable, very energy-efficient, and generates less waste and impurities than the bacteria-based technologies that are being used in alternative routes for bio-based succinic acid (figure 4). Reverdia uses this yeast technology to produce Biosuccinium at best-in-class carbon footprint and economics. The best-in-class carbon footprint is also supported by the Copernicus Institute at Utrecht University in the Netherlands. It conducted a Life Cycle Assessment study, which compared various production methods in detail, assuming all other things are equal (especially the energy mix and feedstock usage). The study found that the yeast-based fermentation process at low pH, with direct crystallization, as used by Reverdia to produce Biosuccinium, has significantly lower greenhouse gas emissions than other fermentation routes or petrochemical routes (fig. 2). The results of this LCA study are published as an early view in Wiley Online Library (August 2013).

Reliable Company, Reliable Product Quality

Reverdia combines DSM's expertise in materials sciences, life sciences and biotechnology with Roquette's know-how in plant-based raw-material processing. These two large international companies have been developing, producing and supplying bio-based products globally for decades.

Reverdia benefits not only from the capital and expertise of both mother companies but also from their production facilities. Biosuccinium formerly was produced in a demonstration plant on the Lestrem site of Roquette in France, and the production facility in Cassano is again backward integrated with a Roquette biorefinery for on-site production of the starch feedstock. The Cassano site benefits from the experience gained in the demonstration plant where Biosuccinium was produced for more than two years. Reverdia's first large-scale commercial plant is using the same low pH yeast technology as was used in Lestrem and can therefore also deliver on product quality promises.

For more photos and graphics, please see the article online.

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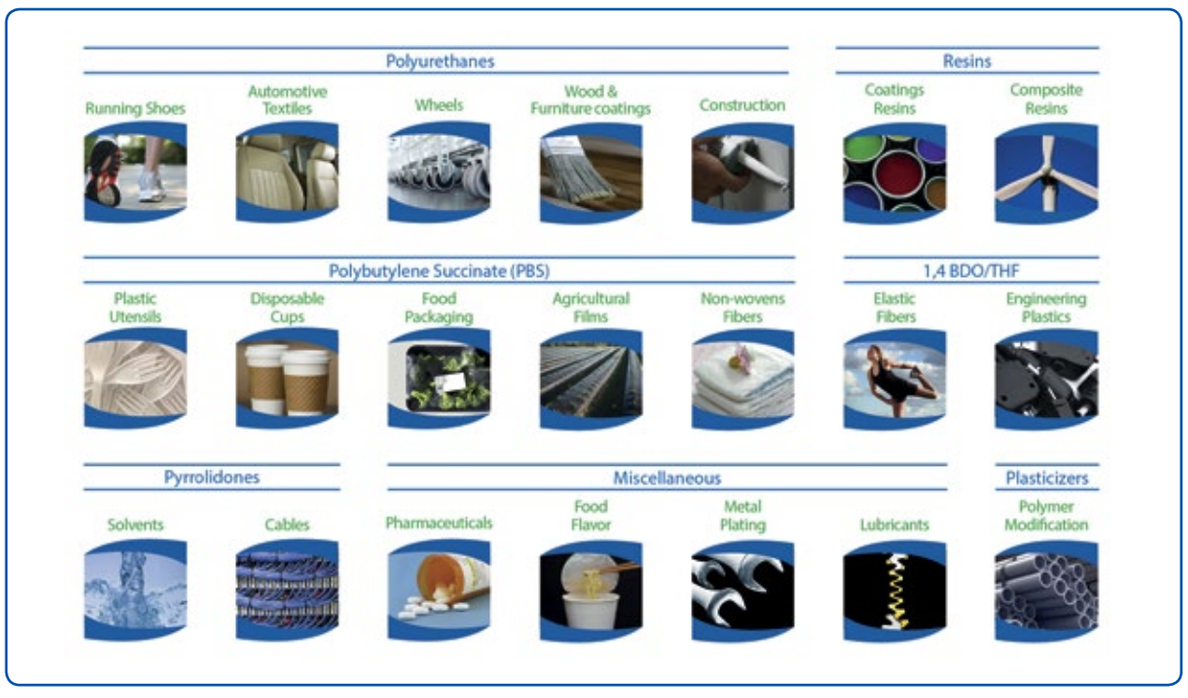
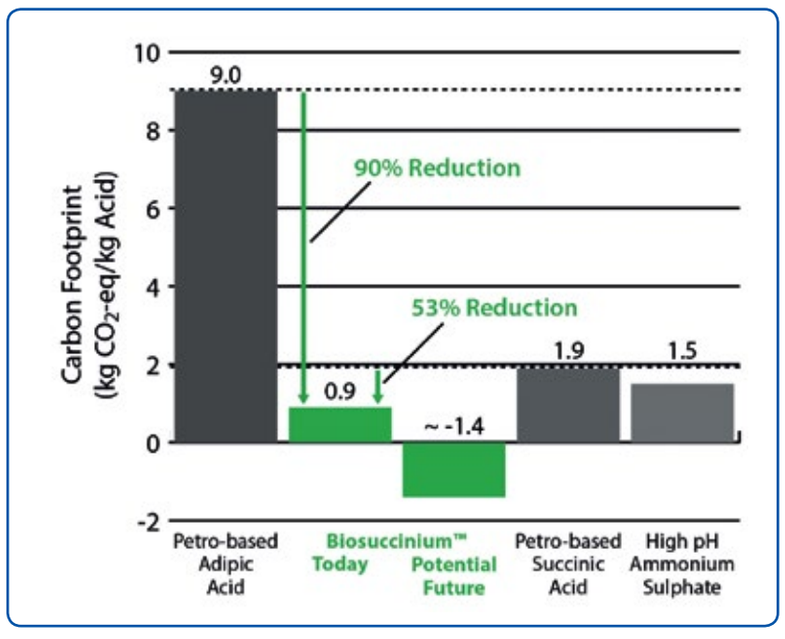


Biosuccinium market opportunities



Reduction in carbon footprint with Biosuccinium