Biobased polymers keep textiles green

Growing demands from brand owners and consumers for fibres and textiles that are more environmentally friendly are now creating a huge market for biobased polymers produced using renewable feedstocks.

One response to this need has been the development of biobased fibres from renewable raw materials. Many biobased polymers have been developed, including polyethylene terephthalate (PET), polyethylene (PE), polylactic acid (PLA), starch blends, biodegradable polymers such as polybutylene succinate (PBS) and poly(butylene adipate-co-terephthalate) (PBAT), thermosets (epoxies, polyurethanes [PUR] and ethylene propylene diene monomer rubber [EPDM]) and cellulose acetate.

These accounted for 2% of global polymer production in 2013. Capacity for such renewable polymers is expected to increase faster than that of conventional polymers, leading to a 4% share by 2020, according to the nova-institute, an organisation dedicated to advancing the use of renewable raw materials.

The textile industry share of worldwide biobased polymer production in 2013 is estimated by the group to be 18%, but expected to decline to 8% in 2020 due to more rapid growth in consumption of biobased polymers/plastics in the packaging sector (which is attributed to the fast growth of biobased PET).

In fact, nova-institute projects production capacity for PET to reach 7m tonnes/year by 2020, while production capacities for PLA and PHA will expand nearly four and tenfold, respectively, between 2013 and 2020.

Examples of leading companies producing biobased polymers and fibres intended for use in the textile industry include DuPont, NatureWorks, Invista, Corbion, Kaneka and Cathay Industrial Biotech.

DUPONT OFFERINGS GROW

DuPont makes Sorona (polytrimethylene terephthalate, PTT) biobased fibres (37% renewably sourced by weight) for carpet and apparel applications via continuous polymerisation of bio-PDO (1,3-propanediol), which is made from fermented sugars, and terephthalic acid (TPA). Sorona production uses 30% less energy and releases 63% fewer greenhouse gas emissions compared to the production of nylon 6, according to Michael Saltzberg, global business director for biomaterials at DuPont.

He notes that growth in the adoption of Sorona is largely due to its unique performance properties, including softness, inherent stain resistance, stretch and recovery and durability; and secondly because of its renewably resourced content, which supports the performance. The company will be introducing new products in late 2016 or early 2017 that will expand Sorona’s colour palette capabilities and facilitate Sorona/natural textile blends.

DuPont Industrial Biosciences also announced in January 2016 that, in collaboration with Archer Daniels Midland Company (ADM), it has developed an efficient, high-yielding, low-cost method for the production of furan dicarboxylic methyl ester (FDME) from fructose. FDME is an attractive biobased raw material for the production of various polymers, such as polytrimethylene furandicarboxylate (PTF), a 100% biobased novel polyester produced via
the copolymerisation of FDMMe and bio-PDO.

The two companies are planning to build an integrated 60 tonnes/year demonstration plant in Decatur, Illinois, to provide potential customers with sufficient product quantities for testing and research.

ChengHong Holding Group in cooperation with the Tsinghua University reported in 2014 that it was constructing a 50,000 tonne/year biodPDO unit and 30,000 tonne/year bio-PTT plant.

The company noted that it uses crude starch and glycerine (a by-product of biodiesel) for the fermentation production of PDO and BDO (1,4-butanediol), respectively, and has gained independent intellectual property rights for its PDO and PTT processes. It also indicated that it was installing PTT spinning and fabric dyeing technologies.

Ingeo PLA from NatureWorks is used to manufacture a wide variety of textile products including apparel, furniture components, household materials, baby care products (diapers), personal hygiene goods and gardening supplies. Ingeo fibres are produced using 40% less non-renewable energy and generate 52% less greenhouse gases than conventional PET fibres, according to Robert Green, global segment lead, nonwovens and fibres with NatureWorks.

When compared to nylon 6, Ingeo fibres reduce non-renewable energy consumption by 67% and greenhouse gases by 81%, Green adds. “Most applications using Ingeo are driven by product performance. The major performance themes are moisture management, breathability and skin comfort for apparel and hygiene products, while for horticultural/agricultural applications, the renewable, sustainable and compostable attributes are highly desired,” he notes.

NATUREWORKS BROADENS RANGE
NatureWorks continues to broaden the performance range with new resin grades for fibre applications and works closely with development partners to optimise processes and performance to demonstrate how Ingeo as a material can offer benefits.

For instance, customers are developing combinations of Ingeo products with natural fibres and other biobased resins to offer functional and sustainable products to the market.

Fitesa Simpsonville, for example, has developed the 100% renewable Fitesa 100% biobased spunbond nonwoven product made of Ingeo and Braskem’s Im green 100% biobased polyethylene. This won the 2015 RISE Durable Product Award from the Association of the Nonwoven Fabrics Industry (INDA).

Corbion Purac initially launched its biobased PLA resin portfolio for extrusion, thermoforming, injection moulding and fibre spinning in Europe in 2015, and for the North American market in May 2016. The company’s new 75,000 tonnes/year PLA production plant is anticipated to start-up within the second half of 2018, and Corbion is currently testing, validating and selling pre-marketing volumes of PLA.

The product range includes PLLA (poly L-lactic acid) and PDLA (poly D-lactic acid) homopolymer resins for high heat, high performance, as well as standard PLA grades.

CHINESE POLYAMIDE DEVELOPMENT
Cathay Industrial Biotech, based in Shanghai, China, received $135m in additional financing in late 2015 that will be used to increase the production capacity at its existing Jinxiang facility and build a new production site.

The company manufacturers long-chain dibasic acids (LCDAs), including renewable dodecanedioic acid and 1,5-pentamethylene-diamine (DN-5), a renewable diamine, that is polymerised with adipic acid to produce Torryl, a biobased polyamide 56, which serves as an alternative to nylon 6 and nylon 66.

The new polyamide has similar strength and wear resistance to traditional nylons, along with improved flowability, moisture absorbance, comfort, dyeability and antistatic and flame retardant properties due to disruption of some of the hydrogen bonds, which provides more sites for interaction with dyes and water, according to the company.

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ROBERT GREEN
Global segment lead, nonwovens and fibres, NatureWorks

In addition, direct polymerisation melt-spinning provides significant cost savings. The company is currently investing an additional $500m to build a new production site for DN5, long chain diacids and biobased polyamides using its own raw monomer blocks in Xinjiang, western China.

The site is anticipated to be complete by May 2017 and will provide 50,000 tonnes/year of DN5, 100,000 tonnes/year of biopolyamides and double the current capacity for LCDAs.

Kaneka PHBH from Kaneka Corporation is a copolymer of a copolymer of 3-hydroxybutyrate and 3-hydroxyhexanoate and a 100% biobased polyester derived from renewable plant oils. The strain development and cultivation technology were achieved through a joint research effort with RIKEN, Japan’s largest research institution.

Compared to PLA, PHBH is soft and has greater heat-resistance, biodegradability, hydrolysis resistance and water vapour barrier properties, according to the company. The production of fibres is a key end-use application.

Several other companies offer biobased fibres. INVISTA introduced a biobased version of spandex in May 2014. Approximately 70% by weight of the new Lycra bio-derived spandex fibre comes from dextrose derived from corn.

Japanese firm Toray manufactures biobased PET. Italian firm Fulgar launched in November 2015 ‘Evo by Fulgar’, a 100% biobased high-performance fibre made of a biopolymer derived entirely from castor oil seed, which is grown in arid regions not suited for other forms of agriculture, according to the company.

Other firms have targeted the development of biobased additives for textile applications. Covestro introduced its Impranol eco range of waterborne, biobased polyurethane dispersions (PUDs) for use as textile coatings. The products contain 43% to 65% renewable content, offer performance that matches conventional products and can be used as drop-in replacements for existing PUDs according to the company.

BIOBASED COLLABORATION
Covestro collaborated with BioAmber, a supplier of biobased succinic acid, in the development of the Impranol eco line. The products recently (May 2016) won the Innovation Award Biobased Material of the Year 2016, an award sponsored by InfraServ GmbH & Co. Knapsack KG, a service provider for the planning, construction and operation of plants and sites.

Organiclick AB developed OC-biobinder, a biobased fibre-binding system used to make nonwovens and textiles stronger and stiffer. The company applies click chemistry to modify and change the properties of both naturally occurring cellulose (wood, cotton, and linen) and manmade (viscose, polyester, polyamide) fibres. “We have developed technologies to add properties such as fire resistance, water repellency, fungal resistance and increased strength,” notes CEO Marten Hellberg.

While continued growth of the market for biobased polymers used in fibres and textiles is expected in the short and long terms as expectations for both greater performance and sustainability increase, hurdles do remain for manufacturers of products manufacturers using renewable raw materials.

“Educating the market about these materials, the sustainability benefits that can be realised and the overall value proposition is one of the biggest challenges,” says Green.

Limited manufacturing capacity for the production of biobased functional fibres is an issue for Hellberg. “Capacities need to increase further, which will also likely reduce the prices for biobased functional fibers,” he observes.

Saltzberg stresses that success in the fibre/textile industries is dependent on not only having a competitive cost structure, but also acceptable properties, and preferably higher-performing properties.