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The 10 Hottest, Bossest Renewable Plastic Technologies

July 2, 2015 | Jim Lane

Plastics — we love the price, performance and versatility. But why not renewable and sustainable, too?

We want it all! And you can have it, with 10 technologies that are changing the landscape. Let's dive into the who and why.

10. Using plastic to make fuels

One way to get plastics out of the landfill, where they pile up as waste, is to find a use for them. Numerous project developers have technology that makes liquid fuels directly from recycled plastic — thereby getting two uses (the plastic, then the fuel) out of a fossil molecule instead of digging up one for the plastic and a second for the fuel. Here are some applications and developers.

In Australia, Foyson Resources is launching a $4 million plant that will convert 200 metric tons of plastics per day to fuel, roughly 50 million liters of diesel and 18 million liters of gasoline, and the first commercial-scale facility of its kind in the country. The first stage of the facility will be online by June.

In India, Indian Railways announced it wants to produce biodiesel for use in its trains using technology patented by the CSIR-Indian Institute of Petroleum. The technology breaks down plastic waste, so in essence is recycled diesel rather than biodiesel. About 850 liters of diesel can be produced from one metric ton of plastic waste.

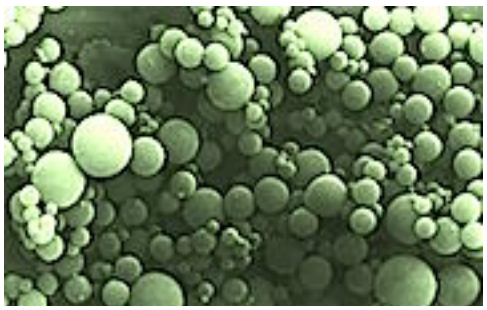
In April 2014, Vadxx Energy broke ground on its $20 million "post-industrial" waste plastic to liquid fuel facility outside Akron. The facility, that should be online by August next year, will process 60 tons of plastic per day using technology designed and built by Rockwell Automation. The company says RA has built other similar plants in the UK.

9. Instant-Dissolve Plastics

Plastics are durable — isn't that part of their appeal? Sure is, for parents looking for an indestructible Big Wheel. But that product may spend eons in a landfill — because we don't know how to make a plastic that lasts a few years. Or, do we?

In December 2014, a discovery made by researchers at North Dakota State University, Fargo identified a new type of plastic that can be broken down when exposed to a specific type of light and is reduced back to molecules, which could then be used to create new plastic. The research team focuses on biomass, using oilseed from agricultural crops, cellulose, lignin and sucrose to generate building blocks of molecules that are made into polymers to create plastics.

In their proof of concept experiment, the group used fructose to create a solution of molecules, which was then converted to a plastic (polymer). By exposing the plastic to ultraviolet light at 350 nanometers for three hours, researchers degraded the plastic, reducing it back to the soluble building block molecules from which it began.



8. MicroSpheres

Inside a host of liquids that require abrasives — such as toothpaste or cosmetics, are non-degradable plastic microbeads that function well and cost little, but are piling up in landfills and spilling over into the oceans and elsewhere. Alternatives? Yes!

In Canada, TerraVerdae BioWorks announced a new line of biodegradable, natural microspheres for use in personal care and cosmetic products, as a direct

replacement for synthetic, non-degradable plastic microbeads that are currently the subject of restrictive legislation throughout the world.

TerraVerdae's natural microspheres are a PHA-based biomaterial produced using a non- GMO, non-toxic, plant-associated process. Unlike other biomaterials that require a compost environment to degrade, TerraVerdae's microspheres are intrinsically biodegradable and meet the American Society for Testing and Materials industry standards for biodegradation in a marine environment. TerraVerdae can produce microspheres in a range of sizes, in both smooth and coarse finishes, that feature high optical clarity and the mechanical characteristics to meet all requirements for cosmetic formulations.

But watch out, TerraVerdae — Mango Materials is hot on the trail, too.

7. Replacing metals

Plastics can replace fossil plastics, but can they replace metals — providing an alternative to heavy objects and mining raw materials from the earth. The next generation of PHA resins are just one opportunity along these lines.

In February 2013, Ghepi – a company specializing in R&D, the injection molding of plastics and "metal replacement" designs – started an experiment which has demonstrated the performance of bio-plastics developed by bio-on.

As a result, bio-on is stating its own biopolymer can now also be used to produce technical articles currently manufactured with polymers or metals. The production process can use the same molds. Bio-on's PHA's are 100% biodegradable in both water and soil.

In June 2015, Bio-on announced its completion of another phase in the development of the technology for making PHAs from glycerol and today stands ready to grant licenses for this new technology to realise the first PHAs bioplastic production plants using biodiesel by-products.
Bio-on technology now enables production facilities producing from 2,000 tons/year to 10,000 tons/year of PHAs to be realised. PHAs, or polyhydroxyalkanoates, are bioplastics that can replace a number of traditional plastics currently made with petrochemical processes using hydrocarbons. PHAs guarantee the same thermo-mechanical properties with the advantage of being completely naturally biodegradable.

6. Thermoplastic composite materials for the automotive market

To become more fuel-efficient, cars need to lightweight — can they do so without sacrificing durability or safety? A new generation of biobased technologies suggest that the answer is yes, and renewably too.

In October 2013, DSM signed a partnership agreement with PlastiComp, Inc., based in Winona, Minnesota, to develop new innovative bio-based Long Fiber Thermoplastic composite materials for the automotive and other performance-driven markets. Central to this partnership is DSM's commitment to sustainability—in this case with its EcoPaXX polyamide 410, 70% derived from renewable resources—and PlastiComp's expertise in LFT composites design and manufacturing. Initial compounding, molding and testing of carbon-fiber reinforced EcoPaXX was successful in establishing benchmark composites for high-temperature (up to 200°C) and structural applications. The two partner companies will also collaborate with potential customers to design injection-molded composite parts.

5. Absorbable medical devices

Temporary medical devices can save lives, but there's the risk of implant and the the risk of ultimate retrieval in many cases. Can the advanced bioeconomy offer a safer approach?

In June 2014, researchers at the University of Michigan reported an interesting application for bioplastic: saving a young child's life with a 3D printed bioplastic trachea. At the age of six months, Kaiba Gionfriddo was diagnosed with a condition that caused his windpipe to collapse. Led by Dr. Scott Hollister, a team from the University of Michigan were able to print a customized biopolymer tracheal splint for the infant using a 3-D printer. The tracheal splint will fully absorb into Kaiba's body in two to three years.

4. Synthetic leather from bioplastic

We love leather's functionality, feel and durability, but regret the source. Could we make it instead of harvesting it from cattle — without sacrificing performance?

Earlier this week, BioAmber announced that the Flokser Group has successfully developed an innovative artificial leather fabric using bio-based materials supplied by DuPont Tate & Lyle Bio Products and BioAmber.

Flokser has launched this new synthetic leather fabric under its SERTEX brand. The novel fabric comprises a polyester polyol made from BioAmber's Bio-SA bio-based succinic acid and DuPont Tate & Lyle Bio Products' Susterra bio-based 1,3-propanediol.

Flokser's artificial leather fabric has 70% renewable content and delivers improved performance. It provides better scratch resistance and has softer touch than current synthetic leather fabrics made with petroleum derived chemicals. The global addressable market opportunity for these bio-based polyester polyols in artificial leather is estimated to be 330 million pounds per year (150,000 metric tons); a 165 million pound market for bio-succinic acid and a 165 million pound market for bio-1,3-propanediol.

In December 2013, Green Dot developed a compostable synthetic leather made with the company's Terratek Flex bioplastic. The new synthetic leather combines the look and feel of high quality leather with a lighter environmental footprint compared to traditional leather tanning or synthetic leather manufacturing.

The material can be returned to nature if placed in a composting environment when its useful life is over. Initial trials have been completed with manufacturing partners in the U.S.. The new synthetic leather can be made in a wide range of colors, textures and thicknesses with a variety of naturally biodegradable backings.

3. The Plant Bottle

Coca-Cola has sold a gazillion Plant Bottles with 30% renewable content, but wants badly to go to 100%, and is investing to make the major ingredient, paraxylene, renewably. What's the latest?

Three companies are in league with Coke — Avantium (which intends to make a novel molecule, PEF, rather than replace PX directly), Gevo and Virent.

News arrived from Europe in June 2015 that Coca-Cola is displaying 100% bio-based content Plant Bottles produced using paraxylene produced at Virent's Madison, Wisconsin demonstration plant — the first demonstration scale production of a PET plastic bottle made entirely from plant-based materials. The bottles were showcased as part of The Coca-Cola Company's pavilion at Expo Milano 2015 a global showcase for sustainable innovation. Far Eastern New Century worked with Virent and The Coca-Cola Company to convert the BioFormPX to bio-PET resin.

The companies partnered in 2011, signing multi-year, multi-million dollar Joint Development and Supply Agreements to scale-up Virent's plant-based Paraxylene (PX), trademarked BioFormPX, as a route to commercially viable, 100% renewable, 100% recyclable PlantBottle PET resin. In the past, Coca Cola's PlantBottles have included only 30% plant-based plastic. Virent's chemical allows the remaining 70% of the bottle to be plant-based.

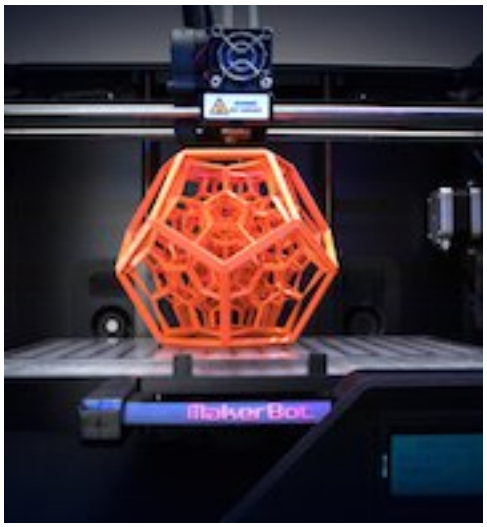
Last year, Virent's partnership with Coca Cola was extended with an additional investment of an undisclosed amount for Virent to scale up production of the paraxylene chemical which Coca Cola is using in their PlantBottles. The investment will fund purchase and installation of new equipment that is needed to chemically produce and purify paraxylene from one of the byproducts of Virent's biofuel production process.

In June 2014, Avantium announced that it has closed a financing round of $50 million from a consortium of iconic strategic players. This unique consortium consists of Swire Pacific, The Coca-Cola Company, DANONE, ALPLA, and existing shareholders. Follow on investments were made by existing shareholders Sofinnova Partners, Capricorn Venture Partners, ING Corporate Investments, Aescap Venture, Navitas Capital, Aster Capital and De Hoge Dennen Capital.

Also in June 2014, Gevo said it had started selling paraxyleme to Toray, one of the world's leading producers of fibers, plastics, films, and chemicals. It's producing PX from isobutanol, one of its three molecules in production (the others are jet fuel and iso-ocrane) at its complex in Silsbee, Texas. Toray expects to produce fibers, yarns, and films from Gevo's PX.

The Toray "buy" is the culmination of a multi-year effort that first surfaced in 2012, when we reported that Toray signed an offtake agreement for renewable bio-paraxylene (bioPX) produced at Gevo's (then) planned pilot plant. The agreement enabled Toray to carry out pilot-scale production of bioPET, and the company was able to offer samples to its business partners, last year.

Using terephthalic acid synthesized from Gevo's bioPX and commercially available renewable mono ethylene glycol (MEG), Toray had succeeded in lab-level PET polymerization to produce fibers and films samples in 2011.



2. 3D Printing

Incredible technology, 3D printing. From replacment parts for astronauts working in space to "printing" entire working cars, it's an astonishing technology, but is only as sustainable as the resins they are made from.

In the 3D printing market, PLA filament has become a material of first choice. The material's low polymer thermal shrinkage allows high-resolution printing for part accuracy and avoids warping of parts. Strong polymer fusing performance makes PLA easy to use and enhances performance. A relatively low melt point enables safe lower temperature printing, and very low emissions means no unpleasant odors when printing.

Again, we turn to NatureWorks, which in May 2015 announced a broad new initiative to support the 3D market comprehensively is based on a three-pronged approach. It includes the introduction of an entirely new series of Ingeo grades designed specifically for PLA filament for the 3D printing market; a full suite of technical support services for the additive manufacturing industry's leading 3D printer and filament producers; and the creation of an in-house print lab, enabling the company to rapidly test new Ingeo formulations and collaborate with printer and filament producers.

1. Replacing ABS — Lego, NatureWorks

ABS. It's the plastic you know from LEGO – incredibly strong and durable. But the manufacture of millions of bricks stimulating the imagination of children to build a better world is not compatible with the sourcing of ABS from fossil fuels, with their resulting greenhouse gases and other hallmarks of an unsustainable planett.

From Denmark comes the news that LEGO will replace its fossil-based plastics by 2030 with sustainable alternatives. The company announced that it will invest $150 million in the effort to cover research, development and implementation of new raw materials to manufacture LEGO elements as well as packaging materials.. Immediately, the company has established a LEGO Sustainable Materials Centre and expects to recruit more than 100 employees in the effort.

Currently, the company uses 6,000 tons per year of ABS (acrylonitrile butadiene styrene) to manufacture more than 60 billion LEGO elements.

But it turns out that LEGO might simply want to make a phone call to NatureWorks, which in April 2015 announced the availability of new ABS replacement formulations "clearly demonstrating that its naturally advanced Ingeo resins have evolved into a practical and safe alternative for a broad range of styrenics in terms of performance, price, and eco profile."

Three new formulated Ingeo injection molding offerings built on NatureWorks' heat-stable technology platform offer a range of impact and modulus performance features in tandem with excellent chemical resistance. Two formulations offer medium and high impact performance with high bio content. This makes them ideal for injection molding applications – particularly those currently utilizing ABS. Additionally, a high modulus Ingeo formulation for profile extrusion applications maintains excellent impact performance and, just as with the injection molding offerings, this formulation's high stiffness (up to 50 percent higher flex modulus) offers opportunities for downgauging and materials savings.

The Ingeo formulation has a renewably sourced carbon content of approximately 90 percent.