

» Plastics

Microbeads: A GREEN alternative

TERRAVERDAE BIOWORKS GEARS UP FOR PRODUCTION

A proprietary process successfully produces non-petroleum-based plastics that safely biodegrade.

BY MARY DEL CIANCIO

A small Canadian industrial biotechnology company is trying to change the world by producing sustainable products through an equally sustainable production process. It sounds like a lofty goal, but Edmonton-based TerraVerdae BioWorks is already making huge strides.

Since it was founded in 2009, the company has been focused on developing an industrial bioprocess with a significant impact on sustainability. Fast forward to 2015 and TerraVerdae has a proprietary bioprocess that has shown success in the development of green alternatives to petroleum-derived plastics and chemicals.

In June, the company revealed plans to release its first line of green products. Less than two months later, TerraVerdae had completed the scale-up of its commercial pilot operation to production. These are major milestones for the company of just 15 people who are focused on the opportunities and challenges ahead.

TerraVerdae's production process involves taking "green" methanol derived from natural biomass sources such as forestry or waste residue, and feeding it to single-celled organisms that grow and multiply to produce raw material – the most significant being polyhydroxyalkanoate (PHA), a bio-based and biodegradable bioplastic. The company then extracts this native material and uses it to develop a range of advanced biomaterials with applications in personal care and cosmetics, biomedical, agriculture, automotive, electronic devices and more.

What makes TerraVerdae's process unique is that it also extracts and uses other high-value material from the bioprocess.

First up is a line of biodegradable

natural "microspheres" for personal care and cosmetic products. These are being marketed as a direct replacement for controversial synthetic, non-biodegradable plastic microbeads, currently the subject of restrictive legislation around the world. Synthetic plastic microbeads, used by some cosmetic manufacturers as abrasives in facial and body scrubs, are too small to be stopped by filtration systems in water treatment plants. As a result, they're polluting freshwater bodies, and harming fish, birds and other wildlife in the process.

TerraVerdae's microspheres are a "drop-in" replacement. The distribution and physical properties are the same as microbeads, but they're intrinsically biodegradable, and meet the American Society for Testing and Materials

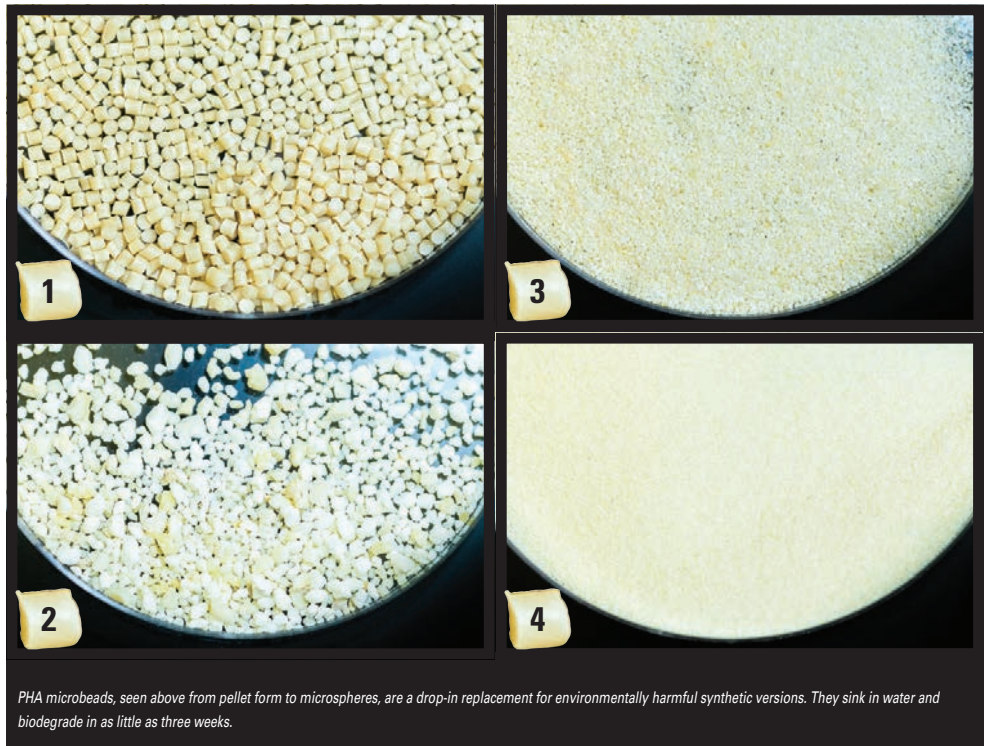


(ASTM) industry standards for biodegradation in a marine environment. Unlike plastic beads, TerraVerdae's spheres sink in water and they biodegrade in as little as three weeks.

"The market opportunity was pretty compelling," says William Bardosh, CEO and founder of TerraVerdae. "We saw a really nice fit for what we produce."

A number of leading companies, including Johnson & Johnson, L'Oreal and Colgate-Palmolive, have already announced plans to end the use of polyethylene microbeads in favour of environmentally sustainable alternatives.

There are other solutions, but Bardosh warns they come with their own set of concerns. For example, nuts and seeds



PHA microbeads, seen above from pellet form to microspheres, are a drop-in replacement for environmentally harmful synthetic versions. They sink in water and biodegrade in as little as three weeks.



TerraVerdae's Edmonton production facility is equipped with a 2,000 litre pilot-scale bioreactor.

PHOTOS: JEFF HILBRECHT

are one alternative, but you don't get a uniform size distribution when they are crushed, which makes them less ideal. The bigger concern, though, is the water requirements for nut trees. Going this route could create another set of environmental problems, says Bardosh. And other bio-based solutions made from sugar-based fermentation may be compostable, but they're just as non-biodegradable as polyethylene.

Many governments are moving to ban the use of synthetic polyethylene microbeads. The Microbeads Free Waters Act of 2015, for example, was filed in the US Senate and the House of Representatives with the aim of phasing out the manufacture and sale of microbeads found in household products by Jan. 1, 2018.

Some areas are proposing legisla-

tion that may take it a step further to include bio-based solutions. California, for example, has introduced a bill that would outlaw plastic microbeads of any form, which could include TerraVerdae's alternative. Bardosh is working to raise awareness amongst legislators to ensure his microspheres aren't lumped in with the synthetics and non-biodegradable bio-based materials.

Canada is actively developing regulations that will prohibit the manufacture, import and sale of personal care products containing microbeads, but the text



TerraVerdae's green biochemistry platform is key to its biomaterial development, including bio-based polymers and chemicals.

WHY EDMONTON?

TerraVerdae's principle development facility is in Edmonton, but the company also has activities in the US and UK. Though CEO William Bardosh, a Canadian, is actually based in Boston, there were a number of factors that drew him to base the company in Edmonton.

He cites the strong support network from the government of Alberta, as well as the technical talent from the nearby University of Alberta. In addition, the location gave his team access to excellent resources and facilities for fermentation scale-up.

Bardosh was also attracted to the city of Edmonton's focus on generating valuable products from waste, because he is like-minded.

And the company found a valuable collaborator in Enerkem. Its waste to methanol production facility in Edmonton is the company's major green methanol source.

of those regulations has not yet been released, so it's not clear whether the language will include bio-based alternatives. Bardosh, however, doesn't expect it to pose a problem for TerraVerdae with its global market.

In fact, there are a number of markets in the US and Europe where legislation has already been passed, or is being passed, which provides a significant opportunity for TerraVerdae to sell its products.

uct that comes out of this at the end has to have the same composition and the same characteristics each time."

There are many challenges facing technology companies today. For TerraVerdae, the biggest ones have been funding, as well as finding qualified people and an industrial space with the right equipment. But the company has faced all of these challenges head on and generated revenue in the process.

"We have set out to undertake a significant challenge, which requires strong support and collaboration..."

With no major concerns about the impact of legislation on his company, Bardosh and his team are moving full steam ahead. TerraVerdae is already working with several major personal care product manufacturers to test the use of microspheres in their products, doing everything from lab tests and analyzing formulations to efficacy testing.

In the meantime, the team is trying to optimize the process for full-scale commercial production. This involves careful planning.

Pilot to commercial scale

As vice-president of bioprocess development for TerraVerdae, Ian Gosling is responsible for scaling up the bioprocess – figuring out how to translate what the team has seen in the laboratory and pilot scale into full commercial production, in addition to determining a location and the equipment to be used.

The team has run the bioprocess at a 10,000-litre commercial pilot scale several times over the last few years at a facility in the UK. Full commercial scale would run anywhere from 200,000 to 250,000 litres.

This involves a lot of logistics, because as you move up in scale, you're using different equipment, often in different locations. Finding the right environment takes time, but it ultimately helps to validate the process and confirm its robustness under a variety of conditions.

The company is working with partners to get there. At the same time, it's continuing to improve the process, including at the 10,000-litre scale, to ensure the yield is high and the process is reproducible.

"You really need to make sure the process is robust [and] that it will work every time," Gosling explains. "The prod-

Bardosh attributes this success to four main factors: vision, people, capabilities and collaborations.

The company remains focused on its vision of changing the way the world develops, produces and consumes products that are sustainable and that meet or exceed the performance criteria of their non-sustainable displaced counterparts.

To help bring this vision to light, Bardosh has selected a great team with a broad range of backgrounds and strong expertise – a competitive advantage for TerraVerdae as it works from feedstock to end product.

Collaborations with academic and industrial stakeholders have also been essential.

"We have set out to undertake a significant challenge, which requires strong support and collaboration from a range of stakeholders, which he describes as key for defining and driving solutions.

TerraVerdae received funding support from various sources – including Alberta Innovates Bio Solutions, Alberta Innovates Technology Futures, the federal IRAP program and others in the US and the UK.

The TerraVerdae team is working on a portfolio of products and plans to release two others later this year or early 2016 when the company is in full production.

It's a long and challenging road from pilot to production, but TerraVerdae remains focused on optimizing its bioprocess to produce sustainable products – and change the world in the process.

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