Plastics Manufacturing Process Reduces Need For Crude Oil, Conserves Resources

University of Maryland

When Professor Lawrence Sita, Ph.D., joined the chemistry and biochemistry department at the University of Maryland in 1999, he was determined to figure out the most effective way to make the kinds of plastics used in shopping bags and automobile dashboards, known as polyolefin plastics.

Then he took a “world-view-changing trip” to India in 2004, where he saw discarded plastic everywhere across the countryside. Trees were laden with plastic bags — so much so that they looked like they were growing plastic.

“What I saw just staggered me,” Sita says. He realized that wanting his contribution to science to be a way to simply make more of the same type of plastic “was a very naïve and pretty ignorant viewpoint.”

But by that point, in 2004, Sita had already made important discoveries in plastics manufacturing. He was working on a new, more efficient way to make polyolefin plastic out of the simple raw materials obtained from natural gas as opposed to crude oil, which is used in the manufacture of many plastics. So he switched his focus from making plastics to making pure, synthetic oils and waxes through the same process.

In 2008 he finalized his invention and founded a company, Precision Polyolefins, which he hopes will soon start selling his products. His technology is a more environmental solution than current manufacturing processes because similar products made from crude oil require so much more refining and shipping — not to mention the geopolitical issues involved — than more readily available natural gas.

Creating a Catalyst

Sita's research has focused on the agent, called a catalyst, that causes the long molecular chains of plastics to form out of the raw materials. In much the same way that enzymes in our body create new materials by controlling chemical reactions between molecules, an artificial catalyst in plastics manufacturing controls how the molecules join up in a specific way to form long chains from which the plastics are derived.

Plastics manufacturers have used various catalysts made from different metals to achieve this goal. But each catalyst can only make one type of plastic, meaning that if companies want plastics of different strengths they have to stop the manufacturing process and substitute in a new catalyst they designed to specifically produce a different type of plastic. Polyolefin synthetic oils and waxes are made using the same process, but by creating shorter chains of molecules than plastics require. (A polyolefin is a chain of repeating hydrocarbon molecules, petroleum being a mixture of different hydrocarbons.)

> *Sita discovered a sort of universal catalyst that can take the raw materials obtained from natural gas and turn it into any desired type of polyolefin plastic, oil or wax.*

The final product depends on the amount of time the catalyst and building blocks spend in the reactor creating shorter or longer chains. Additionally, the process uses special chemical additives that instantaneously reprogram the exact way in which the catalyst stitches the molecular building blocks together to form the molecular chains.

Sita and his graduate student coworkers achieved this by spending 10 years in his lab, picking apart the mechanisms that make catalysts function. They studied them until he could reassemble a new, more versatile catalyst, as opposed to the traditional industry approach of simply screening thousands of different catalysts by trial and error until a new product is "discovered."

"Through generous support by the National Science Foundation over the past 10 years, I had the luxury of saying, 'How do these catalysts work?' instead of needing to make something commercially successful," he says. "The traditional approach is much more empirically driven. We want to have absolute knowledge and control over the structure of both the catalyst and the material."

By 2008 he had developed his universal catalyst and the manufacturing technology that utilizes the new catalyst. The catalyst is made with a tiny amount of an expensive metal called hafnium and a much larger amount of inexpensive aluminum.

The university had been obtaining patents for his work along the way and was eager to recoup on its investment. With the help of the school's Office of Technology Commercialization (OTC), he started looking for companies interested in licensing the technology.

"My preference would have been for some company to come in and license everything," he says. "That would have left me peacefully doing my lab work."

It didn't work out that way.

From Competition to Company

After striking out with existing companies, the OTC invited Sita in 2007 to participate in an annual competition it holds for faculty members to present their business ideas to local entrepreneurs and venture capital investors. Sita won the "Best Inventor Pitch."

"He stood out right away," says Gayatri Varma, OTC's executive director. The key was that Sita stuck to explaining his business plan and didn't veer into the heavy science, as researchers are prone to do.

"I got my plaque and good feedback," Sita says of the competition. He also realized that he needed to do the heavy lifting to bring his catalyst to market. "If something was going to happen, I should take a leading role in trying to get it out the door."

In 2008 he founded Precision Polyolefins, and the university licensed the catalyst technology to him. Sita is about to move the operation into incubator space on campus.

The company is currently a one-man show, but hopefully not for much longer.

In addition to feeling better about his contribution to the environment, Sita realized that it would be much harder to enter the plastics market against giants like The Dow Chemical Co. than it would be to introduce new synthetic oils and waxes.

"The plastics market is very competitive," says Varma, who applauds Sita's business decision. "The price point is very low."

Sita is working hard to find the right investors in this sour economic climate. Varma has helped negotiate a loan from the university to keep the company moving forward.

"We're trying to be a little creative because we want to see this company be successful," she says.

Producing Oils and Waxes

Sita's plan is to focus on synthetic oils at first, and he hopes to have a product out by next spring. These oils could be used as lubricants in places where clean oil is required, such as food processing or medical equipment, or as hydraulic fluid.

The advantage to his universal catalyst in producing synthetic oils is that he can change the desired viscosity of the oil without having to change the catalyst. So he could easily switch between oils and lubricants needed for cars in the Arctic to your run-of-the-mill city car needs.

Eventually he hopes to add waxes to the mix, focusing on high-tech products such as those used in thermostats that have to melt at a specific temperature. The United States currently imports a billion pounds of wax per year — and this will soon increase to 2 billion pounds, he says.

In addition to easing the manufacturing process, Sita says his catalyst is better for the earth. As crude oil becomes scarcer, companies are looking to import cruder and cruder sources that require more and more refining, which is an energy intensive process.

“In the U.S. we have an abundance of natural gas, so it’s a highly desirable starting material for petrochemicals,” Sita says. “The energy required for manufacture is a fraction of what is currently required by crude oil refining. And it would limit the amount of energy that goes into transportation of crude oil, which is not insignificant when you have tankers chugging around the world.”

And, as the country continues to recuperate from the Gulf of Mexico oil spill, people are eager to find ways to reduce the need to find more and more sources of oil.

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