An Environmentally Friendly Process Helps Tires Tread More Lightly

Nelson Mandela Metropolitan University

It's hard to imagine a world without rubber. From automobile tires to washing-machine gaskets, rubber pervades modern life. Unfortunately, it also carries an unwelcome tradeoff. For decades, rubber manufacturing has used a compound — zinc oxide — that harms the environment. The solution to that big problem may rest with a small South African company called Rubber Nano Products. It has unveiled a manufacturing process that eliminates the need for zinc oxide — making rubber production greener and also more efficient.

Rubber's Prevalence and Problems

Current industry trends underscore the need for more environmentally friendly production. According to the International Rubber Study Group, an intergovernmental organization, global rubber consumption reached 24.4 million tonnes in 2010 — a nearly 15 percent increase over 2009. That demand won't abate anytime soon. Forecasts from the

International Rubber Study Group suggest those figures will grow to 26.1 million tonnes in 2011. By 2012, they may hit 27.5 million tonnes. And as rubber consumption grows, so does the use of zinc oxide.

> *Zinc isn't always harmful; in fact, organisms need it to function properly. But in concentrated amounts, it can have devastating effects. When elevated levels of zinc oxide accumulate in water, for example, it can prove toxic for fish, crustaceans and other aquatic life.*

Those concerns have caught the attention of nations worldwide. The European Union classified zinc oxide as "dangerous for the environment" and "very toxic to aquatic organisms," and the U.S. Environmental Protection Agency has listed zinc as a pollutant to closely monitor to ensure water quality.

Rubber manufacturers don't want to harm the environment — but lacking other viable, affordable options, they've adhered to zinc-oxide processes for many decades. With its zinc-free approach to rubber production, Rubber Nano Products hopes that will soon change.

Enhancing the Ingredients

It takes more than good intentions to convince large manufacturers to swap deeply ingrained production methods for

something greener. "One of the issues in rubber manufacturing is that it's pretty much been made the same way for 100 years," says Jacqueline Barnett, M.Sc.Eng., MBA, director of Innovation Support and Technology Transfer at Nelson Mandela Metropolitan University (NMMU) in Port Elizabeth, South Africa. "To actually change the way people do things is rather problematic."

While attending graduate school at Nelson Mandela Metropolitan University several years ago, Robert Bosch, M.Sc., chose to tackle that challenge. As a field of study, rubber appealed to him because of its "inherent unknowingness." Says Bosch: "There was a massive amount of things going on in rubber that scientists don't understand." That includes more detailed knowledge of the chemical reactions in rubber manufacturing.

For years, the basic components have worked like this: By adding sulfur to natural rubber, chains of large rubber molecules (called polymers) bond to each other, creating a durable material.

Chemicals called accelerators help speed up the process, and zinc oxide serves as the activator that tells those reactions when to start.

"It's almost the same as baking, chemically," says Bosch. As with baking, rubber manufacturing means more than mixing the right ingredients. The process requires heat to cure the rubber — making it harder and reliable enough to produce automobile tires that work safely for thousands of kilometers.

While at Nelson Mandela Metropolitan University, Bosch discovered a new twist on that traditional approach to rubber

manufacturing, with the help of his supervisors, Chris Woolard, Ph.D., and Katherine Garde, Ph.D. In 2008, the researchers identified a biodegradable substance that does the work of zinc oxide. What's more, this zinc-oxide replacement has benefits beyond its environmental impact. By altering the chemical reactions of manufacturing, it reduces the cure time for rubber. This means manufacturers could use less energy to produce the same quality product. While still a university student, Bosch founded Rubber Nano Products to market the new process, currently named ZR-6.

Easing the Growing Pains

To help build momentum for the discovery, South Africa's National Research Foundation and the Nelson Mandela Metropolitan University funded the early stage research. Bosch also enticed two experienced industry people from rubber chemical distributors to join the business, as managing/financial director and marketing director. Financing for late-stage development came from Bosch's friends, family and business connections, as well as from Nelson Mandela Metropolitan University.

The university's support didn't stop there. Of the three patents currently held by Rubber Nano Products, two used to belong to the university. In her role as head of the university's technology transfer office, Barnett facilitated the patent's ownership change to Rubber Nano Products. As a result, the university became a shareholder in the company, and Barnett now serves as a director. When Rubber Nano Products faces cash-flow issues for patent costs, she ensures the university covers those costs so the company doesn't lose the patents.

Barnett also assists the startup company by identifying the right lawyers to provide legal advice and ensuring Bosch has the proper equipment to help refine his company's product. That's because the university allows Bosch to use its laboratory facilities, even though he's no longer a student there. "Things can get stuck in university bureaucracy if there's not an office to drive things forward," says Barnett. That access has beencrucial for the company.

Bosch agrees.

"NMMU has been very cooperative in the manner it handled the transfer of the intellectual property into the commercial entity as well as very accommodating in allowing some of the business R&D to occur in their labs," says Bosch. "This has saved valuable resources for the business."

Like most technologies that emerge from universities, Bosch's discovery needed significant development work before it reached market-ready status. So far, the product has gone through six updated versions.

After overcoming technical challenges with product formulation, the company faced a formidable hurdle: How do you craft a sales pitch compelling enough to revolutionize an entire industry? "You say, 'Forget what you've learned, there's a new set of rules,'" says Georg Cronje, managing director of Rubber Nano Products. "And they look at you as if you've come from Mars."

At first, Cronje and his colleagues assumed the product's environmental merits would be enough to win over manufacturers. They soon learned companies like to talk about going green but won't act without a stronger business incentive. So they changed their pitch and focused instead on Rubber Nano Products' ability to provide a more efficient curing process — while touting the greener approach as a bonus.

ZR-6 can shorten rubber's cure time by about 15 percent, and it also allows that process to happen at a lower temperature. The reduction in both time and energy costs has resonated with manufacturers.

"If they were making 60,000 tires a day, now they have the ability to manufacture an additional 12,000 tires, without investing in additional mechanical equipment," says Cronje. "Suddenly it becomes a lot more attractive."

That also makes a persuasive sales pitch in developing nations, where environmental concerns play an even smaller role, says Cronje. "Let's face it, if we go knocking on their doors, saying, 'Look, we've got a biodegradable, environmentally friendly alternative to zinc oxide,' nobody is really going to fall over."

Already, the greener process has gained acceptance in a wide range of industrial products, including conveyor belts, shoes, gaskets, hoses and other non-tire-related rubber applications. (Bosch is even working on a rubber horseshoe to

provide a more comfortable experience for horses.) In this case, “acceptance” means manufacturers have started using ZR-6 in industrial trials. Some have taken the next step and placed commercial orders to use ZR-6 in their rubber process.

Rubber Nano Products manufactures its product locally, but that will change as the company focuses more on international markets. The company has already established a partnership with a European distributor, and plans to do the same in Asia, the United States and other regions.

Making Inroads with Tires

ZR-6 has made inroads within nontire rubber manufacturing because those products have easier criteria to meet, notes Bosch. But the greener process will make the biggest impact when tire manufacturers adopt it. Zinc oxide can represent as much as 5 percent of a tire’s mass. In terms of zinc-oxidesources that pollute the environment, tires rank highest.

Several tire manufacturers have started trials using ZR-6, but the approval process will take time. “Tires are a life-bearing device,” says Bosch. New tire development can take up to five years, he says, so he doesn’t expect to see ZR-6 accepted in the tire industry for another two or three years.

However, the tire retreading industry has potential for earlier adoption. “Some of our biggest approvals have actually come from retreading companies,” says Bosch. “The core of the tire is the same — we just need to prove our product is as strong as the tread that’s being replaced.”

That’s just the beginning. Rubber Nano Products has hardly tapped the potential to transform rubber manufacturing into a greener industry. Cronje estimates the worldwide market share for ZR-6 could ultimate reach about 120 kilotonnes. “Even if we achieve 10 percent of that, it would be a good start,” he says.

As adoption of this new process increases, it signifies the best of both worlds for the rubber manufacturing industry. Those companies can now rethink the way they make products that enhance quality of life — and do so more efficiently, without short-changing the environment.

This story was originally published in 2011.