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DAILY COVER



# Inside The Startup Whose Technology Promises An American Energy Transformation

## With $100 million in funding, Niron looks to scale up production of permanent magnets without using rare-earth materials from China, which pose a national security risk.

**BY AMY FELDMAN, FORBES STAFF**

In an industrial area of Minneapolis, an under-the-radar startup is working on a process to create permanent magnets without rare-earth materials.

At the pilot plant, workers take iron in powdered form and bubble nitrogen through it to create iron nitride, an extremely magnetic material. It sounds simple — both iron and nitrogen are readily available and inexpensive — but iron nitride is fickle and hard to make.

For nearly a decade, Niron, whose technology is based on research at the University of Minnesota, has been developing a process for which it has 56 patents and another 21 pending. The need for a rare-earth alternative is enormous at a time when the demand for permanent magnets, used in everything from electric vehicles to wind turbines to consumer electronics, far outstrips the supply and relies on materials from China. Rare-earth alternatives historically haven't been as powerful as the permanent magnets they hope to replace, but Niron says its iron-nitride magnets can already do the job in many cases and it's continuing to improve the technology.

That helps explain how the startup has raised more than $100 million — including $60 million from investors and another $42 million from the federal government — with plans for additional fundraising. Today, the pilot plant produces just 100 kilos of magnets and the company brings in minimal revenue. But it's begun scoping out locations for a full-scale production facility, which would cost hundreds of millions of dollars, that it expects to open within the next three or four years. "We have a solution to the rare-earth crisis," says Niron CEO Jonathan Rowntree.

While little-known to most consumers, permanent magnets power our modern lives. They go into motors and generators that enable electricity to be transformed into motion and motion into electricity. Permanent magnets made with rare-earth materials are a key element of the country's efforts to decarbonize with electric vehicles and wind turbines. Because of their higher performance — allowing smaller, more powerful motors than alternatives — their use has spread and continues to rise. Global demand for rare-earth magnets is expected to increase at 7.5% compounded annually through 2040, according to Adamas Intelligence.


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At Niron's pilot plant in Minneapolis: The company has an aggressive plan for future production of its rare-earth-free permanent magnets.

The problem is that demand is rising so fast that there isn't enough supply to meet it. More troubling, the vast majority of these magnets come from China, which has reportedly been considering prohibiting exports of some rare-earth-magnet technology following Washington's restrictions on semiconductors.

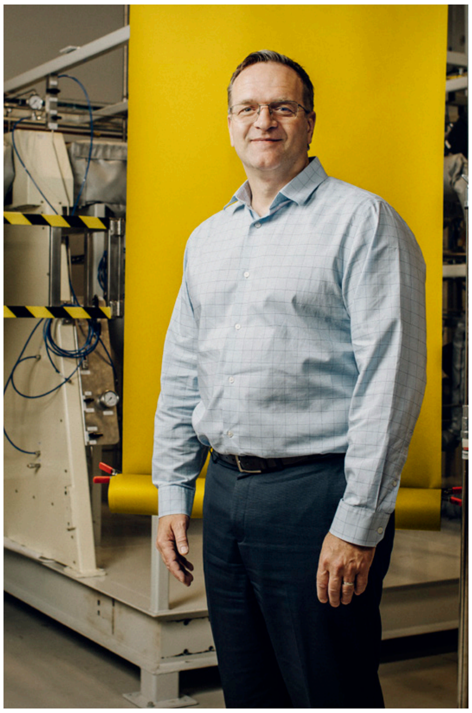
In February, a Commerce Department report concluded that the current level of rare-earth magnet imports "threatened to impair the national security." Its recommendations included a tax credit for domestic manufacturing and continued investment through the Defense Production Act. In April, Representatives Guy Reschenthaler (R-Pa.) and Eric Swalwell (D-Calif.) introduced a bipartisan bill to support domestic rare-earth magnet manufacturing with tax breaks.

A number of U.S. companies are working to fill the gap. Noveon is building a factory in Texas that can recycle old magnets. MP Materials, a publicly traded $3.9 billion (market cap) firm that owns a major rare-earth mining and processing facility at Mountain Pass, California is building a facility in Fort Worth, Texas. It'll have a capacity of 1,000 tons of finished magnets and a long-term agreement to supply General Motors. Two other U.S.-headquartered firms, Quadrant Magnets and USA Rare Earth, as well as the German company Vacuumschmelze, have plans to establish U.S. magnet manufacturing facilities by 2026.

Niron argues that given rising demand, as well as the environmental consequences of rare-earth mining and processing, new technology is needed to fill the gap. "It's not going to be enough, and it's never going to be enough," says Andy Blackburn, Niron's executive vice president of strategy and its former CEO. "There's not enough deposits and you can't recycle your way to meet the demand. The Chinese have done us a great favor — not that this was their intent."

Niron's technology is based on research developed by University of Minnesota professor Jian-Ping Wang, who's spent most of his life studying magnets. "I was amazed by the mystery of magnetic materials," he says.

Iron nitride, the material Niron uses



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**Jonathan Rowntree of Niron.**

for its rare-earth-free magnets, was discovered in the 1950s. Many researchers tried to understand it, recalls Wang, 56, who was born in China. Hundreds of papers were published through the 1990s, but after efforts failed to explain the material's properties and experiments proved difficult to reproduce, interest waned, he says. By the time he joined the University of Minnesota in 2002, he says, the topic was out of favor.

"I think, 'I need to work on this, I need to explain this, otherwise no one in industry will step in because they feel it is controversial,'" he says. For half a dozen years, Wang hunkered down with a student, doing basic research and publishing nothing. "I know it's controversial and there had been debate before so we needed to make sure we had everything right," he says. "The most important part is, 'Do you have a theory to explain it?' If you cannot explain it, you cannot go further and create new compositions."

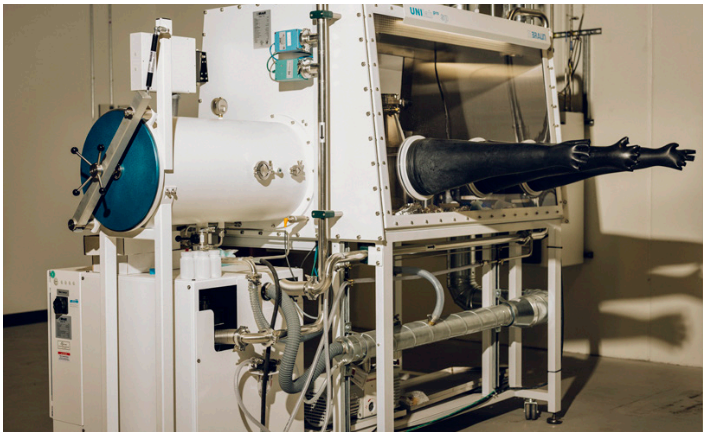
In 2010, after seven years of research and help with testing from Los Alamos and other national labs, Wang made a presentation at the American Physical Society's annual meeting. Word spread fast, and soon Wang was fielding interview requests to talk about his work. "I never thought it would come this far," he says. "I wanted to answer the question of why people couldn't make this material again, and why people couldn't explain this material and its performance using textbooks of the existing theory. That's what drove me for six, seven, years, and then I got an answer and I felt very happy about that."

Among the calls following the presentation, in 2010, was one from a program director at the Department of Energy's ARPA-E research division, who wanted to know if iron nitride could be used to make permanent magnets. A year later, Wang received a $4.5 million grant from the agency. At his university lab, he explored multiple ways of making magnets with iron nitride, including the one that Niron now uses for production.

In 2014, the company spun out of the University of Minnesota with early investment from Artiman Ventures. Wang, who was inducted into the National Academy of Inventors, was the firm's first chief technology officer; he remains on the board of directors and is chief scientific officer today. More recently, Niron has signed on Volvo and hard disk-drive maker Western Digital, both of which have large needs for permanent magnets, as strategic investors. "This is a major moonshot effort to come up with a new recipe," says David Michael, managing partner at Anzu Partners, which invested in 2016.

While alternatives to rare-earth magnets have typically shown decreased performance, Niron says that iron nitride has higher magnetic strength and the advantage of maintaining performance at higher temperatures. But the company is still working on bringing the technology to its full potential. Rowntree, the CEO, says that while its current magnets will work for certain applications, such as speakers, it could take another 18 months for researchers to increase their performance to the level required for motor applications.

"It's a tricky material to make," says Blackburn, the vice president for strategy. "It's literally iron and nitrogen in a particular crystal structure that is highly magnetic. Everyone knew it was highly magnetic, but no one could make it at high purity. That's the nut we could crack."



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In early 2021, Tymphany, which makes automotive audio systems, came across a paper that Wang had published in the *Journal of Magnetism* and *Magnetic Materials*. The company was interested in permanent magnets that worked without rare-earths, especially to replace those that were expensive and subject to roller-coaster pricing, Chris von Hellerman, Tymphany's vice president of acoustic technology, tells Forbes by email. Dysprosium, a heavy rare earth that's often added to permanent magnets to increase their performance, especially at high temperatures, is particularly pricey.

Today, Tymphany is running tests on Niron's magnets, a key step toward bringing them into commercial production. Hellerman says he sees potential for Niron's magnets to bridge the gap between rare-earth magnets and ferrite magnets, which are widely available but less powerful. "We see indications that Niron's magnet material roadmap could disrupt the rare-earth magnet supply and help to provide alternatives to the existing China supply of rare-earth magnets," he says.

Misco Speakers, a St. Paul, Minnesota-based maker of custom speakers used in commercial aircraft, medical devices and other products, also discovered Niron a few years ago and went to visit the factory with a team of engineers. Loudspeakers use many grades of magnets, and president Dan Digre says that he expects Niron's magnets will first replace the lower-grade ones, but over time he'd hope to switch out all of the rare earths. That would not only give the family-owned business a secure supply of magnets at a stable price, he says, but also offer it an advantage in using — and marketing — clean magnetic technology. "The Niron product could be a game-changer for our industry," he says.

Some two dozen other partners across areas that include automotive, consumer electronics and power tools are working on pre-production sampling of Niron's magnets. Niron has fielded calls from dozens of manufacturers interested in learning more or talking about collaboration agreements. "Literally, I think we've had between 150 and 200 inbound requests with no marketing," Blackburn says. "We're sort of picking and choosing who we're working with."

In January, Rowntree, 52, formerly an executive at Henkel and Rogers Corp., took over the CEO role from Blackburn, 64, to expand the company. A chemical engineer by training, Rowntree had spent nearly 30 years building plants and scaling operations in electronic materials. Since joining, he says, Niron has made "tremendous progress" in getting ready to scale up, while also bringing its capital costs down in order to "significantly lower" its break-even point.

Production today from the pilot plant is small, but Niron has an ambitious road map. "Our goal is that we will be at 1,000 kilos by the end of this year or early next, at 10,000 kilos at the end of next year and 100,000 kilos the following year," Rowntree says. He says the company is now starting its site selection process for the commercial plant that could produce up to 10 million kilograms of magnets a year — with state economic incentives a major factor — with the goal of starting construction in 2025 and completing the buildout in another 18 months to two years.

In March, Tesla announced that its next generation of electric vehicles would contain no rare-earth materials, a high-profile move that Rowntree says caused a spike in inbound interest.

The question is whether Niron will be able to expand beyond the pilot stage, an extraordinarily capital-intensive and technologically complex undertaking. Rowntree says that Niron will seek private-equity investment, as well as additional funding from the government, to get its plant built. His ultimate goal is to build magnet factories in North America, Europe and Southeast Asia.

"We're at this inflection point of scaling and we're at the inflection point of where the technology is at and there are tailwinds that are helping us geopolitically," Rowntree says. "There's the environmental piece and there's the geopolitical piece if China decides to turn off the spigot on rare earths. There is a high sense of urgency to solve this."