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Green Ventures

Institute of Technology alumni are working toward a greener future with innovative products and technologies

Eric Granstrom (MatSci Ph.D. '99, MBA '04) has pioneered a process that is cleaner for the environment in making transparent conductive films for solar panels, touch screens, plasma televisions, e-paper, and electromagnetic interference filters.

RICHARD ANDERSON

Eric Granstrom leans over a microscope in his lab and peers at an image of a greener future.

Before him lies a tiny piece of transparent polymer laced with a fine matrix of silver nano particles. The conductive mesh is too small to be seen with the naked eye, yet Granstrom and his colleagues at Cima NanoTech envision many applications for this innovative technology—solar panels, touch screens, plasma displays, and more.

Here in a technology park just east of the University of Minnesota's Minneapolis campus, this start-up company has developed a novel process for making transparent conductive mesh with natural processes—ones that don't produce massive streams of waste or deplete rare earths as existing technologies do. Better yet, Granstrom says they can do it for less than half the price of competing technologies.

"It's green and has benefits that float right to the customer's bottom line," he said. "It's not just green in a nebulous sense, but it's also green in a tangible, dollars, bottom-line sense."

This is just one example of how the University of Minnesota's Institute of Technology alumni are venturing toward a greener future. What follows is more about Granstrom and two other alumni who are using their expertise to pursue cleaner technologies, innovate new methods of making biofuels, and promote electric cars.

The Matrix

Granstrom (MatSci Ph.D. '99, MBA '04) is vice president of research and development and general manager of Cima NanoTech. The St. Paul-based company is pioneering cleaner methods to make transparent conductive films for solar panels, touch screens, plasma televisions, e-paper, and electromagnetic interference filters. The company relies on an innovation they refer to as the Self Aligning Nano Technology for Electronics, or SANTE™ process, which takes

advantage of natural forces to make these products with less environmental impact.

In the SANTE process, silver nanoparticles are suspended in an emulsion of water and oil. This substance is spread onto a polyester film substrate, and within 10 to 60 seconds, water droplets grow in size, and then ultimately dry, leaving behind a controlled matrix of silver wires like an old skeleton decorating where the emulsion droplets had been. These particles are so small that 1,000 of them aligned end-to-end are only as thick as a human hair. The microscopic mesh is conductive, transparent, and so flexible, given its porous, nano-structure that it can be stretched by up to 30 percent. The process can also be adapted to use other substrates like glass or silicon or other metals like gold.

According to Granstrom, the SANTE process is less expensive and more environmentally friendly than existing techniques of photolithography (which uses hazardous chemicals and produces truckloads of waste) and indium tin oxide (which has a limited supply, is expensive, brittle, and is non-recyclable).

"We just put the silver down, let Mother Nature push it into the right spot and then we're done," Granstrom said. "In an environmental sense, it's a much nicer process. It shows up in the pocketbook of our customers as an extraordinarily cheaper process as well."

The technology has many potential applications—and one of the greenest is on solar panels. Photovoltaic cells need a mesh that is both transparent and conductive; it must admit sunlight and allow electricity to flow to external contacts. "When we use a green process to make the customer's solar cells more powerful, the net impact is much greener yet," Granstrom said. Cima NanoTech launched its first commercial products in 2009 and foresees an array of future applications.

Granstrom personally has never strayed far from the University of Minnesota. In his teens, he participated in the University of Minnesota Talented Youth Mathematics Program. While earning his undergraduate and master's degrees at Carleton College, he did three internships in the Institute of Technology in mechanical engineering, physics, and chemical engineering. Granstrom returned to the University to earn a doctorate degree in materials science and engineering (he also earned an MBA from the University's Carlson School of Management).

Today, he works two miles from his former haunts at Cima NanoTech's global headquarters, which is housed at the University Enterprise Laboratories in St. Paul (the company also has research and development and production facilities in Israel, manufacturing in Japan, and the CEO is based in Singapore).

His bookshelf is lined with textbooks from his grad school days and he frequently draws on many aspects of his graduate education, including metallurgy, polymers, electronic materials, semiconductor physics, or chemical engineering.

"There's not a part of my education that I'm not using here," Granstrom said. "I have to use the litany of everything I had in materials science."

"A Ph.D., particularly one in materials science, doesn't ground you in just your own specialty area," he said. "It gives you the background to dive into a breadth of projects."

Better Biofuels

Clayton McNeff (Ph.D. Chem '96) wants to turn stinkweed and pond scum into energy.

McNeff is part of a team of innovators who have pioneered a new method for producing biofuels from waste oils, weeds, and even algae.

"This is something the world desperately needs," McNeff said. "It can create a green sustainable economy here in the United States. This technology can enable the replacement of all fossil fuels in a worldwide basis."

McNeff grew up around the family business, the SarTec Corporation, which produces products for the agricultural, livestock, and golf course industries. He learned the fundamentals of running a business and spent summers working in the SarTec lab.

After earning his undergraduate degree at Augsburg College, McNeff came to the University of Minnesota for a Ph.D. in analytical chemistry and studied separation science under chemistry professor Peter Carr.

McNeff and Carr saw the commercial potential of their research and founded a company called ZirChrom Separations, Inc. to manufacture zirconia-based columns, which are used for high performance liquid chromatography (a technique for analyzing mixtures of compounds). These pencil-sized columns are used heavily in the pharmaceutical industry and later served as the catalytic reactor for a new process in making biofuels.

In 2006, one of McNeff's former professors at Augsburg informed him about a student who had discovered that zirconia could be used as a catalyst to make biodiesel. McNeff and his colleagues saw potential in the new application and began attacking the problem.

RICHARD ANDERSON

Silver nanoparticles are suspended in an emulsion of water and oil in Cima NanoTech's Self Aligning Nano Technology for Electronics, or SANTE™ process.

Clayton McNeff and his colleagues invented the Mcgyan Process in which they are able to use lower-quality plant oils to make biofuel.

RICHARD ANDERSON

"What ensued was a full research program with thousands and thousands of experiments and many long nights," McNeff recalls. "It was very similar to what I had done in my Ph.D. research at the University of Minnesota, systematically attacking the problem. As we kept pushing forward, we realized this was something that was novel and revolutionary in terms of making biofuels."

They named the new technique the "Mcgyan Process" (a combination of the names of the three inventors). It uses an heterogeneous metal oxide-based catalyst reactor that creates biodiesel from plant oils and animal fats that previously had been unusable. McNeff believes this breakthrough may transform the biofuel industry.

The old technique of producing biofuels relies on a process developed in the 1930s and requires food-grade feedstock. In contrast, the Mcgyan process can use lower-quality plant oils and waste tallows—which don't compete with food—to make biodiesel.

One exciting potential source of energy is algae, which can double its biomass in a few hours. Although this remains in the research stage, McNeff is confident the Mcgyan process could someday provide enough biodiesel to meet the current United States demand of 63 million gallons with a 70-square-mile area of algae production. Another potential source is stinkweed, otherwise known as Pennycress, which McNeff said could produce about 100 gallons of biodiesel per acre.

Even better, the production process is greener. According to McNeff, it produces low emissions, less waste, and has a smaller physical footprint than conventional biofuel plants. It also doesn't produce any soap byproducts or use water and hazardous chemicals.

This past summer, the project took a big step forward with the opening of the new Ever Cat Fuels production plant in Isanti, which will produce four million gallons of biodiesel per year using the Mcgyan process. The team also has set up a licensing company to spread the technology as widely as possible. McNeff foresees other applications such as fragrances and flavors for foods and perfumes.

"Biodiesel," he said, "is just the beginning."

Driving Change

Jim Johnson (AgEng '66) wants to change the world one vehicle at a time.

Putting his agricultural engineering degree to a novel use, Johnson started out selling tractors and wound up owning one of the largest electric vehicle dealerships in the world—MC Electric Vehicles based in Seattle, Wash.

"It's a major paradigm shift—like going from adding machines to computers," he said. "We need to stop

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Jim Johnson (AgEng '66) owns one of the world's largest electric vehicle dealerships, which is based in Seattle, Wash.

burning oil because it just doesn't make sense, so it's logical to shift to these plug-in electric vehicles."

After growing up on a farm in Lindstrom, Minn., Johnson knew he didn't want a farming career. At the University's Institute of Technology, he earned a degree in agricultural engineering (a combination of civil engineering, mechanical engineering and machinery courses).

After graduation, he took a job with Caterpillar, the giant machinery company. A few years later, he joined a Caterpillar distributor in the Pacific Northwest to see the business take off with the construction of the Alaskan Pipeline. Business boomed, yet the environmental depredation disturbed Johnson.

He rose to the company's top and earned a graduate degree in business, yet he longed to start his own business after realizing he wasn't excited about building dams, freeways, and pipelines.

In 1978, Johnson finally pursued his dream. He bought a two-acre site in Seattle and started selling lighter machinery. Although his business has remained in the same location, Johnson has constantly reinvented it in response to economic and technological trends.

In 2003, he planned to retire to Hawaii, but saw a new opportunity in electric vehicles.

"The business had meaning," he said. "It gave me a gut feeling—this is something we need to do to preserve our earth."

Johnson bought 30 electric vehicles and began selling them to customers that included a senior housing complex with golf courses. The original vehicles were 48 volt with wet lead acid batteries and DC motors.

He eventually expanded into electric cars, trucks, scooters, motorcycles, and all-terrain vehicles, which are classified as NEV (neighborhood electric vehicles) and street legal. They are limited to 35 mph, run on up to 96 volts, and have AC drives. In all, he has sold more than 500 vehicles and carries nearly a dozen lines, which he believes makes him the largest dealer in the United States and perhaps the world.

Now with multiple locations in the Pacific Northwest, last year MC Electric Vehicles sold 300 vehicles and achieved $3 million in sales. Johnson anticipates more growth in the face of rising oil prices and looming carbon cap regulations.

According to Johnson, an electric car charged at off-peak hours can be driven for about one-half cent per mile. Washington State also offers electric vehicle incentives, such as sales tax exemption. State agencies provide free electric car plug-ins and so do many local establishments.

The City of Seattle recently installed more than 2,500 electric charge outlets for battery powered car users. "The money savings and other benefits from not buying gas is reinforced with our Federal government now offering up to $7,500 in tax credits for buying an all-electric vehicle," Johnson said.

Johnson continues to pursue the latest in electric vehicle technology. He and another Institute of Technology alumnus, John Hansen (EE '64), recently traveled to China to look at zinc fuel cells as a possible energy source. He expects to have a highway-speed, all-electric vehicle next year that uses lithium ion cobalt batteries.

Johnson has shelved his retirement plans and continues to spread the gospel about electric cars.

"Every time a customer leaves here, we congratulate them for making a difference," he said. "We not only improve the environment, we protect our customer's value in their vehicle, with no sales tax and a tax credit."

"This is a tremendously exciting time as new technologies emerge," he added. ■

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