New Discovery in Fluorine Chemistry Poised to End PFOA Woes

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Manufacturers of stain-repellents, non-stick cookware and other fluoropolymer-based materials will soon have an alternative to using controversial PFOA when developing such supplies. Fluorine chemist and Trinity Western University Professor, Chad Friesen, PhD, has developed a revolutionary environment-friendly process that utilizes a stable compound originally used as a lubricant.

Presently, some fluoropolymers are manufactured using the essential processing aid, perfluorooctanoic acid (PFOA). PFOAs, along with other perfluorochemicals, are extremely useful in industry because their unique molecular structure prevents them from mixing with water or oil, allowing regular materials to become impermeable to grease or water.

Recently however, PFOAs have come under fire for their potential toxicity to humans and their increased prevalence in the environment.

Alerted to these concerns eight years ago, Professor Friesen, who has worked on top-secret projects with NASA and the US military, began modifying the fluorous biphase process in search of a more environment-friendly solution.

“The fluorous biphase process is extremely important because it allows expensive metal catalysts to be recycled,” explains Friesen. “Obviously this significantly reduces energy consumption and business costs. So I wanted to maintain this principle, but alter it so there would be no chance of a harmful byproduct remaining.”

In collaboration with DuPont, one of the world's top research and development corporation, and with research assistance from select TWU students, Friesen identified poly(hexafluoropropylene oxide), or poly(HFPO). This ligand is a non-toxic, non-biocummulative fluorinated ether that does not break down to PFOA and appears to be safe for humans. In certain applications, poly(HFPO) could provide alternatives to materials such as Teflon®. Friesen, 33, is no stranger to cracking difficult problems. At age 25, while working at DuPont, he cracked a problem that scientists had been working on for 40 years and found a use for hazardous chemical byproducts.

Completing the most recent project has been a labour of love for Friesen as funding to complete it has been surprisingly tight.

"It took four years to convince NSERC (The Natural Sciences and Engineering Research Council of Canada) that we could solve the problem," explains Friesen, who was overjoyed when he finally got the news about receiving the grant this year. "They didn't believe we were actually achieving this level of research. In the past TWU has been known for its liberal arts education, not science and research, despite thriving in areas like chemistry, biology, computer studies and nursing."

The constant rejection for funding despite consistently meeting the demands of the Council was discouraging. Friesen and colleague Craig Montgomery, an inorganic chemist at TWU, both became adjunct professors at SFU at the request of NSERC, apparently to affirm their credibility, but they were still denied the grant. Finally, after filing for a patent, demonstrating their relationship with DuPont, collaborating with SFU, and establishing years of consistency, the chemists finally landed a $100,000 grant—$20,000 a year for five years—and are now able to continue the ground-breaking analysis of fluorous biphase catalysis.

"We've got about 40 different versions of the poly(HFPO) to make and we've made three so far," says Friesen. "The funding will allow us to hire more graduate and undergraduate researchers and fine-tune the process."

The funding will allow for more students like fourth-year Daryl Nyvall to participate. Nyvall is the fifth consecutive TWU student to be offered a year-long paid internship with DuPont. Several of the interns have even been listed on the patent, thanks to the research they conducted at TWU. Nyvall will be listed on the patent for poly(HFPO).

"The internship positions are highly competitive," says Friesen, "and they're awarded to only the very best. For the last five years we've had one student interning there each year and we've heard back that our students have been stellar."

How the chemical process works

Friesen explains the fluorous biphase process as functioning like the mythical Trojan Horse. The horse is the catalyst in the reaction and the soldiers hiding inside of it are the metal. Once the horse gets past the gate, the metal is released to do the work in the reaction. The horse's tail, which is fluorinated and temperature sensitive, calls the soldiers back into the horse and they leave.

The problem with the reaction is that sometimes the tails falls off, converting to an acid and leaving cause for environmental concerns. Until Friesen's discovery, scientists had only the option of altering the molecular building blocks of the catalyst's tail, but had done so without viable success.

Friesen however, took a different approach. Instead of attaching a ridged fluorinated material to the tail, he used a flexible poly(HFPO). In this reaction, if the tail falls off, it remains an ether (not an acid) and is of no harm to humans or the environment. In certain applications, poly(HFPO) could provide alternatives to materials such as Teflon.

Source: Trinity Western University