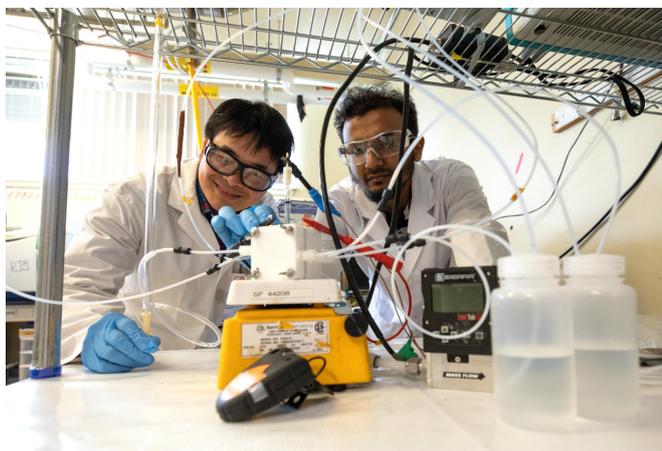


New catalyst upgrades greenhouse gas into renewable hydrocarbons

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ethylene. Ethylene is a common industrial chemical that is a precursor to many plastics, such as those used in grocery bags.

The system addresses a key challenge associated with carbon capture. While technology exists to filter and extract CO₂ from flue gases, the substance currently has little economic value that can offset the cost of capturing it—it's a money-losing proposition. By transforming this carbon into a commercially valuable product like ethylene, the team aims to increase the incentives for companies to invest in [carbon capture technology](#).

Dr. Cao-Thang Dinh, left, and Dr. Md Golam Kibria demonstrate their new catalyst. In a paper published today in *Science*, their team demonstrated most efficient and stable process for converting climate-warming carbon dioxide into the building blocks for plastics, all powered using renewable electricity. Credit: Laura Pedersen

A new technology from U of T Engineering is taking a substantial step towards enabling manufacturers to create plastics out of two key ingredients: sunshine and pollution.

Today, non-renewable fossil fuels not only provide the raw material from which plastics are made, they are also the fuel burned to power the manufacturing process, producing climate-warming carbon dioxide (CO₂)—the International Energy Agency estimates the production of the main precursors for plastics is responsible for 1.4 per cent of global CO₂ emissions.

A team led by University of Toronto Professor Ted Sargent is turning this process on its head. They envision capturing CO₂ produced by other industrial process and using renewable electricity—such as solar power—to transform it into



Dr. Cao-Thang Dinh sets up his new catalytic device to convert carbon dioxide to ethylene. Credit: Laura Pedersen

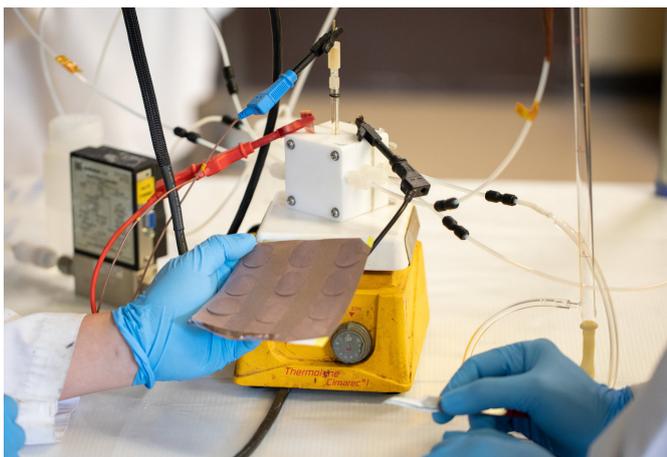
At the core of the team's solution are two innovations: using a counterintuitively thin copper-based catalyst and a reimagined experimental strategy.

"When we performed the CO₂ conversion to ethylene in very basic media, we found that our catalyst improved both the energy efficiency and selectivity of the conversion to the highest levels

ever recorded," said post-doctoral fellow Dr. Cao-Thang Dinh, the first author on the paper published today in the journal *Science*. In this context, efficiency means that less electricity is required to accomplish the conversion. The authors then used this knowledge to further improve the catalyst and push the reaction to favour the formation of ethylene, as opposed to other substances.

Next, the team addressed stability, which has long been a challenge with this type of copper-based catalyst. Theoretical modelling shows that basic conditions—that is, high pH levels—are ideal for catalyzing CO₂ to ethylene. But under these conditions, most catalysts, and their supports, break down after less than 10 hours.

The team overcame this challenge by altering their experimental setup. Essentially, they deposited their catalyst on a porous support layer made of polytetrafluoroethylene (PTFE, better known as Teflon) and sandwiched their catalyst with carbon on the other side. This new setup protects the support and [catalyst](#) from degrading due to the basic solution, and enables it to last 15 times longer than previous catalysts. As an added bonus, this setup also improved efficiency and selectivity still further.



Cao-Thang Dinh shows his team's catalytic device to convert carbon dioxide into the valuable chemical ethylene. Credit: Laura Pedersen

"Over the last few decades, we've known that

operating this reaction under basic conditions would help, but no one knew how to take advantage of that knowledge and transfer it into a practical system," says Dinh. "We've shown how to overcome that challenge."

Currently their system is capable of performing the conversion on a laboratory scale, producing several grams of [ethylene](#) at a time. The team's long-term goal is to scale the technology up to the point where they are able to convert the multiple tonnes of chemicals needed for commercial application.

"We made three simultaneous advances in this work: selectivity, energy-efficiency and stability," says Sargent. "As a group, we are strongly motivated to develop technologies that help us realize the global challenge of a carbon-neutral future."

The multidisciplinary group, which also includes mechanical engineering professor David Sinton, combines strengths in materials science, chemical engineering, chemistry and mechanical engineering, is providing new perspectives on the field. Several members are also involved in CERT, the University of Toronto team that just advanced to the final round of the NRG COSIA Carbon XPRIZE. The Carbon XPRIZE competition challenges groups from industry and academia to capture [carbon](#) emissions from power plants and efficiently convert them into valuable chemical products.

More information: "CO₂ electroreduction to ethylene via hydroxide-mediated copper catalysis at an abrupt interface" *Science* (2018). [science.sciencemag.org/cgi/doi ... 1126/science.aas9100](https://science.sciencemag.org/cgi/doi/10.1126/science.aas9100)

Provided by University of Toronto

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