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Researchers develop a catalyst to make CO2 into fuel

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Researchers at the Massachusetts Institute of Technology have created a stable catalyst that can convert carbon dioxide to fuel while using only a trickle of electricity.

The material can be used to recycle waste gases, curbing greenhouse emissions as well as creating a useful product. These products, like methane, can be sold to offset pollution reduction costs and provide another energy source. The researchers published their results earlier this month in the journal *Chemical Communications*.

Using a blend of copper and gold formed into nanoparticles, the new recipe overcomes some of the previous challenges to developing an efficient way to repurpose carbon.

"Copper is an attractive metal for carbon dioxide reduction," explained Kimberly Hamad-Schifferli, an associate professor in mechanical engineering at MIT. The metal is generally cheap and reacts in well-understood ways. However, it oxidizes when it's exposed to air and moisture, turning from a lustrous brown to a pale green, as seen on the Statue of Liberty. This renders the metal ineffective as a catalyst, she noted.

Since the reaction takes place on material's surface, researchers make the process more efficient by forming the copper into tiny particles, thereby increasing the catalyst's surface area. But doing this accelerates oxidation, as well, rendering the substance inert in as little as 20 minutes.

To get around this, Hamad-Schifferli and her team mixed in gold, a relatively stable metal that drastically slowed oxidation to several days. The researchers mixed gold and copper salts in a solution and heated it to form the hybrid particles.

Zhichuan Xu, a postdoctoral researcher at MIT working on the project, said the new catalyst recipe carries another advantage: It uses less energy than previous materials to convert carbon dioxide to other forms.

Making methane or methanol is anybody's guess

For the catalyst to work, it needs an outside voltage. The researchers found that the hybrid nanoparticles only needed a tiny amount of energy. The experiment indicated that the carbon dioxide binds to their surface, reacts to form methane and other hydrocarbons and then quickly moves along, allowing the reactions to progress.

"This means we actually improved the energy efficiency of the process," Xu said.

To use the catalyst, Xu said that carbon dioxide -- say, from a smokestack or an exhaust system -- needs to be dissolved in a liquid. The fluid then must flow over the copper and gold as a voltage is applied, producing hydrocarbon fuels, which are then harvested.

Though gold is more expensive than pure copper, Xu said the efficiency and durability improvements and the reaction products can offset the increasingly pricey metal's upfront costs.

But there are still challenges. Right now, the researchers can't control what kinds of hydrocarbons are produced, whether they are methane, methanol or a longer-chained molecule, so they need to figure out what's going on at a molecular level as they perfect the recipe.

"What we would like to do is get a better understanding of the surface and structure of nanoparticles," said Hamad-Schifferli.

Xu envisions solar and wind energy powering the mechanism so that the process will not produce any new greenhouse gases. Though the fuels produced through this recycling will likely not become a primary fuel supply and will still produce carbon emissions, the new catalyst can effectively reduce net emissions, thus cutting impacts on climate change.

"It's still very interesting because if you can artificially do this job, you can build up very good fuels and a good balance