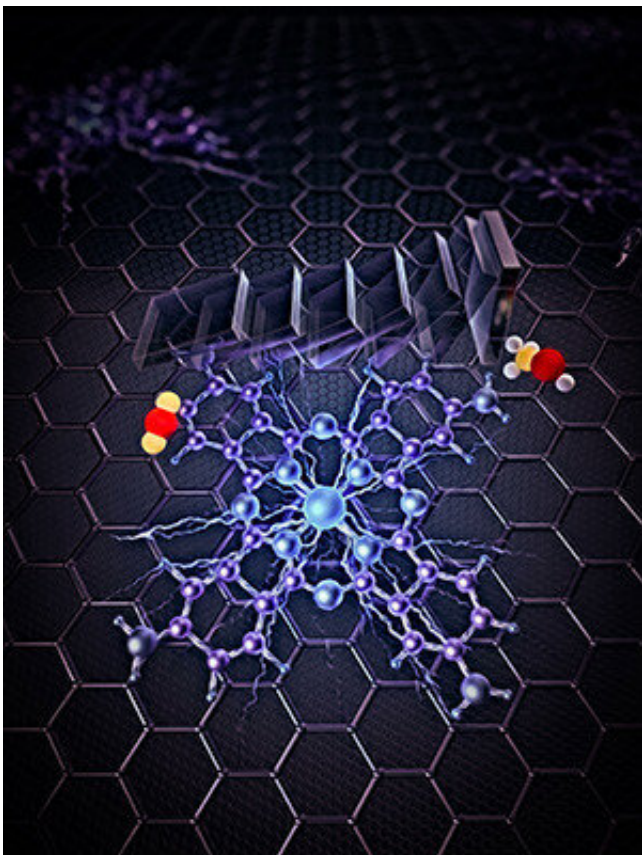


An electron highway headed for methanol

November 28 2019, by Jim Shelton



A conception of a new catalyst that converts carbon dioxide and water to methanol — the catalyst uses carbon nanotubes to create a “highway” for electrons. Credit: Hailiang Wang lab

Making methanol just got a lot easier, now that chemists at Yale have opened up a new electron highway.

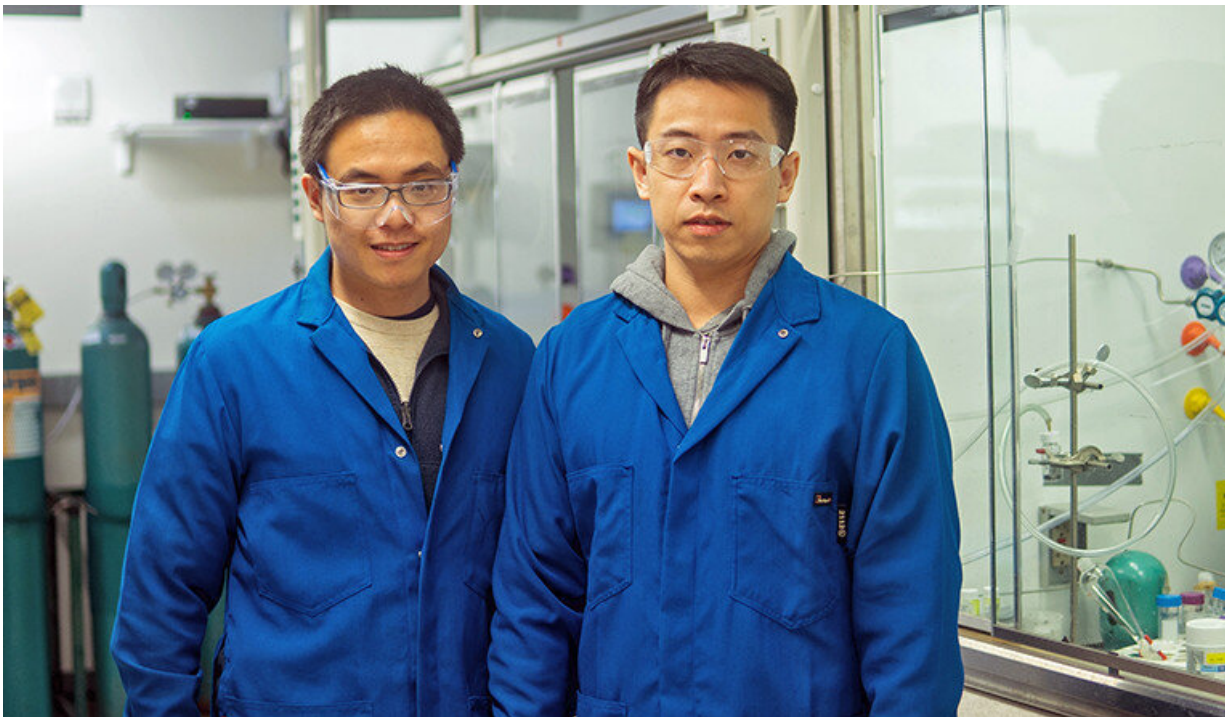
The discovery, published online Nov. 27 in the journal *Nature*, finds a novel solution for two chemical tasks: producing methanol—a volatile, [liquid fuel](#) that is prized by industry—and removing [carbon dioxide](#) from the atmosphere. Hailiang Wang, an assistant professor of chemistry at Yale and member of the Energy Sciences Institute at Yale's West Campus, led the research.

Methanol is used in a variety of products, including antifreeze, paint thinners, and glass cleaners. It is also used to produce biodiesel fuel, plastics, plywood, and permanent-press clothing.

Yale researchers developed a catalyst that converts carbon [dioxide](#) and water into methanol using electricity. It's a type of catalyst called a heterogeneous molecular electrocatalyst—"heterogeneous" because it's a solid catalyst material operating in a liquid electrolyte, and "molecular" because the active site of the catalyst is a [molecular structure](#).

The distinct structure of the new [catalyst](#) is the key, Wang said.

He and his team anchored individual molecules of cobalt phthalocyanine (or its derivative) onto the surface of carbon nanotubes, nanometer-sized tubes of rolled up graphene layers. The nanotubes act like a highway for electrons, creating a rapid and continuous delivery of electrons to the catalytic sites for converting carbon dioxide to methanol. It is a six-electron reduction process, the researchers said, meaning that six electrons are injected into one carbon dioxide molecule.



Yueshen Wu (left) and Xu Lu, co-authors of the new study. Credit: Hailiang Wang lab

Prior to this discovery, a more limited delivery of electrons—a two-electron reduction process—meant molecular catalysts were only able to convert carbon dioxide into products such as [carbon](#) monoxide.

"Heterogenized molecular catalysts allow our group to do new chemistry and known chemistry in better ways, and this is one example," Wang said.

Yueshen Wu, a graduate student at Yale, is first author of the study. Co-authors are postdoctoral fellow Xu Lu of Yale and associate professor Yongye Liang and graduate student Zhan Jiang of the Southern University of Science and Technology in China.

More information: Yueshen Wu et al. Domino electroreduction of CO₂ to methanol on a molecular catalyst, *Nature* (2019). [DOI: 10.1038/s41586-019-1760-8](https://doi.org/10.1038/s41586-019-1760-8)

Provided by Yale University

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