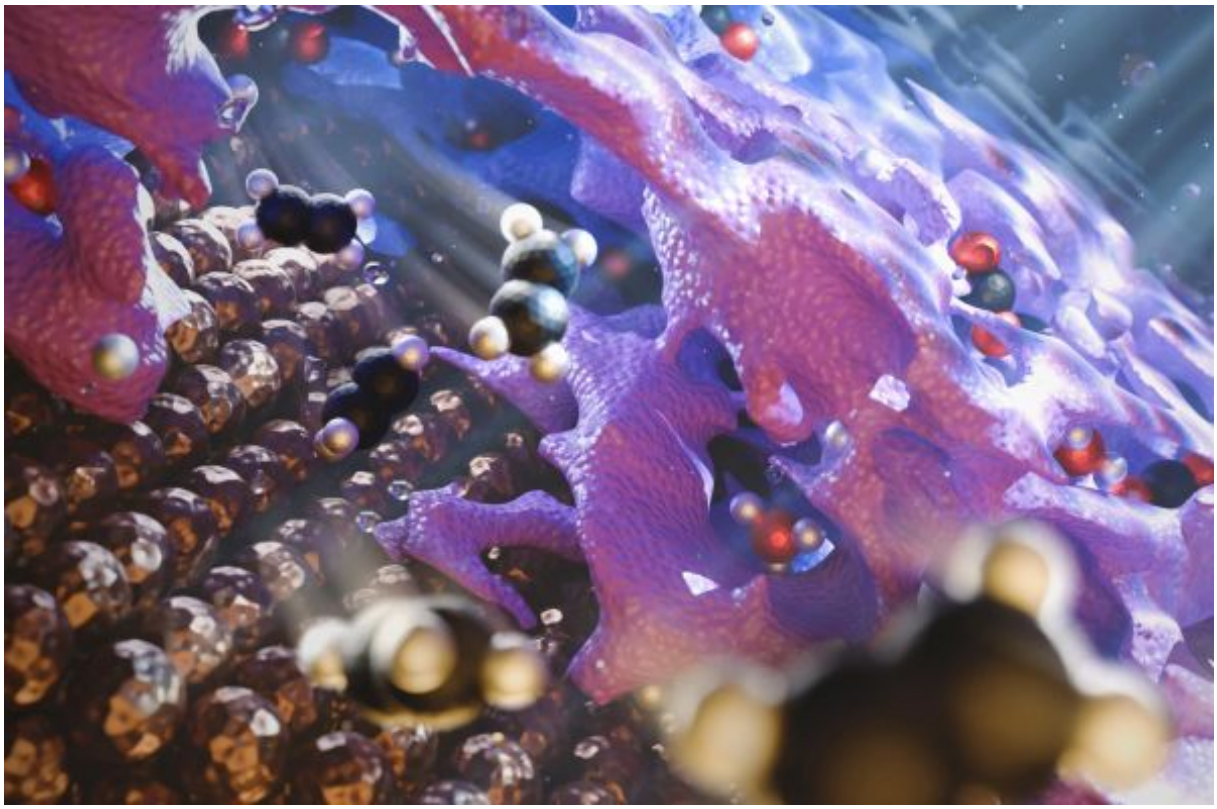


Lock and stock: a new coating enables efficient CO2 conversion into useful chemicals

Carbon dioxide (CO2) is widely known as one of the most common greenhouse gases. While it is natural and beneficial in moderate amounts, human activities have increased its atmospheric concentration to the point of causing global warming and endangering life on Earth. Several actions have been proposed to reduce it and, even better, to convert it into useful chemicals. In this way, we could both take advantage of the CO2 surplus and mitigate the greenhouse effect.

ICFO researchers have now designed a special coating for the electrodes used in the conversion of CO2 into ethylene, ethanol, and other compounds with industrial and energy-related purposes. The coating was designed to remain effective even under challenging acidic conditions, which are essential for preventing the spontaneous loss of CO2 into undesired products. The team has reported in the Journal of American Chemical

Society substantial improvements in the production of desired chemicals compared to traditional approaches, presenting a new path toward CO2 utilization technologies.

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A promising path to mitigate and eventually revert greenhouse effects associated to carbon emissions and global warming is the capture and **conversion of CO2 into useful** products. CO 2 electroreduction enables the generation of specially appealing chemicals such as **ethylene** (the world most produced organic compound, used as a precursor in the polymer industry) **and ethanol** (which can be readily used as a fuel and incorporated into existing supply chains).

Obtaining these multicarbon products at high rates was recently achieved through CO2 electroreduction in neutral and basic media. Unfortunately, this came together with a strong intrinsic limitation. Most of the CO2 spontaneously reacted with hydroxyl species and was lost into unwanted carbonate, making the process more expensive and harder to scale up. While CO2 reduction in acidic environments is an alternative, such proton rich environment brings a different challenge: the more protons (H+) available, the easier the byproduct hydrogen (H2) is produced, consuming electricity that should be destined to convert CO2 into multicarbons instead.

To address this, researchers at ICFO, **Dr. Barbara Polesso**, **Adrian Pinilla-Sanchez**, **Dr. Eman H. Ahmed**, **Dr. Anku Guha**, **Dr. Marinos Dimitropoulos**, **Blanca Belsa**, **Dr. Viktoria Golovanova**, **Dr. Lu Xia**, **Ranit Ram**, **Dr. Sunil Kadam**, **Aparna M. Das**, **Dr. Junmei Chen**, **Dr. Johann Osmond**, **Adam Radek Martinez**, led by **Prof. at ICFO F. Pelayo Garcia de Arquer**, together with the Center for Nanophotonics from the University of Amsterdam (AMOLF), have developed a special polymeric coating for the electrodes, reported in the Journal of American Chemical Society, which modulates the chemical environment to facilitate the CO2 reduction process.?

At the beginning, the researchers tried to work with a well-studied material, a ionomer, an found that its structure (and hence function) was deteriorated with increasing acidity. Base on this insight, they designed a strategy to i¿½locki¿½ its structure and chemical fun tion down to very acidic conditions. By incorporating a special type of polymer with a bra ched structure and an amine function, they finally stabilized the original ionomer. Additionally the resulting polyionomer **regulated proton activity**, offering a handle to supress the creation of hydrogen gas, and **stabilized reaction intermediates**, which is essential to produce ethylene, ethanol, and related compounds. ?

The polyionomer was then implemented in a flow-cell electrode, leading to promising results The team recorded an improvement of almost 30% in the generation of multicarbon product and 35% in the utilization of carbon atoms compared to the traditional approaches.**Thus, the study marks a promising step toward ultimately turning CO2's damage into an ally.**

References:

Polesso, et. al., Chemostructurally Stable Polyionomer Coatings Regulate Proton-Intermediate Landscape in Acidic CO2 Electrolysis, J. Am. Chem. Soc. 2025, 147, 27278?27288.

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