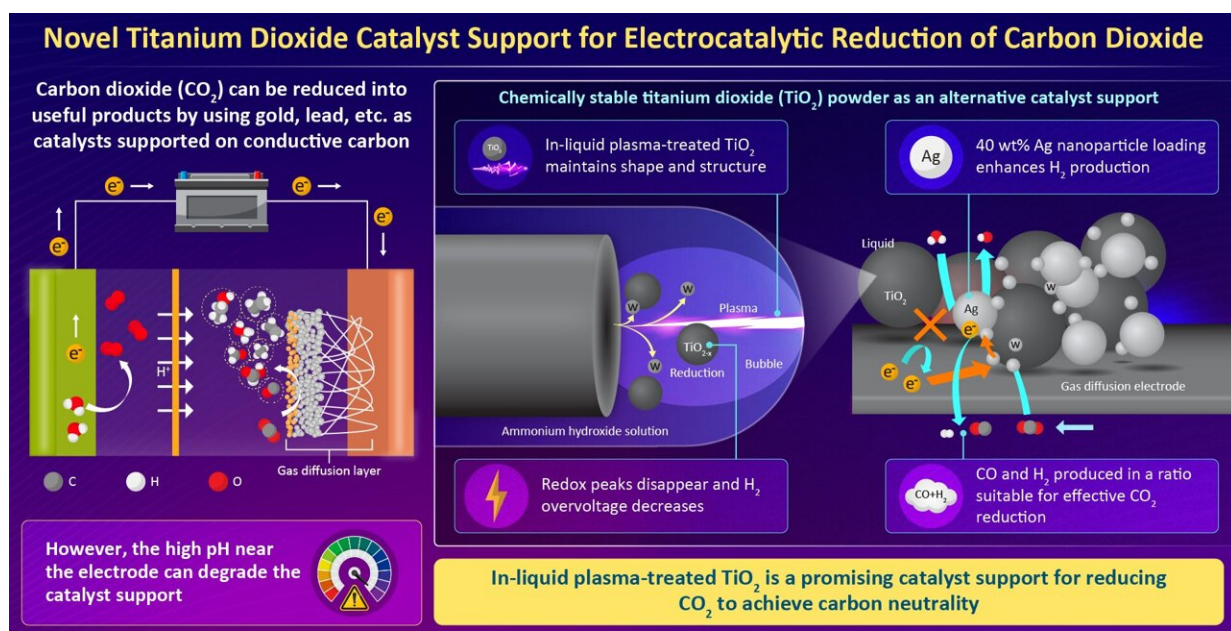


Novel titanium dioxide catalyst shows promise for electrocatalytic carbon dioxide reduction

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Synergistic effect of Ag decorated in-liquid plasma treated titanium dioxide catalyst for efficient electrocatalytic CO₂ reduction application
 Takagi et al. (2023) | *Science of the Total Environment* | DOI: 10.1016/j.scitotenv.2023.166018

Researchers from Japan propose an in-liquid plasma-treated titanium dioxide catalyst support decorated with silver nanoparticles as an alternative to carbon catalyst for effective carbon dioxide reduction into valuable resources. Credit: Chiaki Terashima from TUS, Japan

The conversion of atmospheric carbon dioxide (CO₂), a greenhouse gas,

to useful resources such as carbon monoxide, formic acid, and methanol and their byproducts is considered a promising route to mitigating global warming as well as generating economic value. One approach to CO₂ conversion is through electrocatalytic reduction.

This process utilizes conventional catalysts, such as lead, silver, tin, copper, gold etc. supported on conductive carbon as electrode material for selectively CO₂ reduction. However, the electrode is often exposed to a high pH environment of the electrolyte during electrocatalysis, which can degrade the catalyst support and is a cause of major concern.

To address this challenge, a team of researchers, led by Mr. Kai Takagi and Prof. Chiaki Terashima from Graduate School of Science and Technology and Research Institute for Science and Technology at Tokyo University of Science (TUS) in Japan, has recently developed a catalyst support based on titanium dioxide (TiO₂) powder, a compound commonly used in sunscreen, paints, coatings, toothpaste, plastics, paper, pharmaceuticals, and food coloring, as an alternative to carbon for facilitating effective CO₂ reduction.

Their work was published in *Science of the Total Environment*.

The researchers first carried out surface treatment using safe and inexpensive in-liquid plasma to improve the electrochemical properties of TiO₂.

"The in-liquid plasma-treated TiO₂ maintained its particle shape and crystal structure. Additionally, elemental analysis and evaluation of the interfacial bonding state and electrochemical properties of TiO₂ revealed that the redox peaks corresponding to Ti⁴⁺ and Ti³⁺ derived from TiO₂ disappeared and the hydrogen overvoltage decreased," said Prof. Terashima.

These observations led the team to conclude that tungsten coating or doping occurred on some portions of the reduced TiO₂ surface.

The researchers then used the TiO₂ as a carrier and loaded it with silver nanoparticles (AgNPs), which act as catalysts, to develop a gas diffusion electrode for CO₂ reduction. While untreated TiO₂ exhibited high selectivity for CO₂ and carbon black, in-liquid plasma-treated TiO₂ with 40 wt% AgNP loading demonstrated increased hydrogen production and enhanced catalytic performance.

Given that a suitable ratio of hydrogen to [carbon monoxide](#) is important for effective CO₂ reduction, the presented technology, thus, has tremendous potential for converting CO₂ to useful byproducts, such as syngas, which is considered a clean fuel with very high industrial value.

Additionally, the electrocatalytic reduction of CO₂ can be integrated with [renewable energy sources](#), such as solar panels or wind power, for sustainable and environmentally friendly CO₂ conversion. Therefore, this work is a significant step towards efficiently tackling [greenhouse gas](#) emissions and fighting climate change.

"Hopefully, the present study will promote research on technologies for carbon neutrality and carbon recycling, in alignment with the United Nations Sustainable Development Goals 7, 12, and 13 on affordable and clean energy, responsible consumption and production, and climate action, respectively. These, in turn, will open doors to the realization of a carbon-neutral and sustainable future," concludes Prof. Terashima.

More information: Kai Takagi et al, Synergistic effect of Ag decorated in-liquid plasma treated titanium dioxide catalyst for efficient electrocatalytic CO₂ reduction application, *Science of The Total Environment* (2023). [DOI: 10.1016/j.scitotenv.2023.166018](https://doi.org/10.1016/j.scitotenv.2023.166018)

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