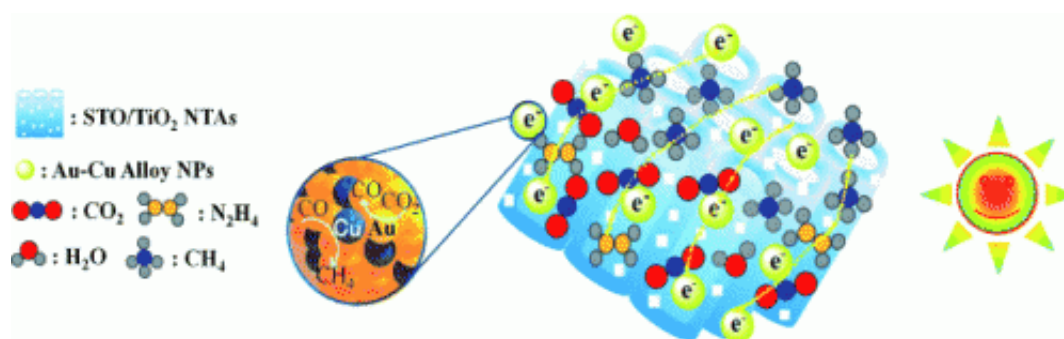


Efficient catalytic system for the photocatalytic reduction of CO₂ to hydrocarbons

December 5 2014



Hydrocarbons continue to be our primary source of energy. However, they do not necessarily have to come from fossil sources. Why not reverse the combustion process to make the hydrocarbons from CO₂? This could be achieved by means of a solar-power-driven process if suitable catalysts were available. Researchers from Japan and China have now introduced a new, particularly efficient photocatalytic system in the journal *Angewandte Chemie*. It may bring us a step closer to CO₂-neutral fuels.

Various catalysts for the photocatalytic reduction of CO₂ have previously been developed, such as those based on strontium titanate (SrTiO₃, STO) or titanium dioxide (TiO₂). Given the special energy

levels of these two [semiconductor materials](#), a heteromaterial made by combining the two seemed like a particularly promising approach to the research team headed by Jinhua Ye. The scientists from the National Institute for Materials Science (NIMS) and TU-NIMS Joint Research Center, Tianjin University produced arrays of coaxially aligned STO/TiO₂ nanotubes. They evenly loaded the nanotubes with nanoparticles of a gold-copper alloy to act as co-catalyst. Hydrazine hydrate (N₂H₄•H₂O) acted as the source of hydrogen and maintained the necessary reducing atmosphere. This system allowed the researchers to very efficiently convert CO₂ to CO and methane (CH₄), as well as other hydrocarbons.

Irradiation with sunlight releases electrons within the semiconductor nanotubes. The STO/TiO₂ heterostructures allow the subsequent charge separation to be maintained better than in the pure substances. The electrons are transferred to the bimetallic precious [metal nanoparticles](#) and from there to the CO₂, the resulting CO, and other gaseous intermediates. The [large surface area](#) of the nanotube bundles and the porosity of the nanotube walls facilitate a high degree of gas diffusion and ensure efficient charge transport. Special effects resulting from their alloyed state allow the gold-copper nanoparticles to stop the return of photogenerated electrons in the semiconductors much more effectively than the pure metals. The hydrazine hydrate provides the necessary hydrogen, resupplies electrons to the catalyst, and forms a reducing atmosphere, which stabilizes the metal nanoparticles for a long time. If water is used as the hydrogen source instead, the catalytic system is rapidly deactivated. On the nanoparticles, CO₂ is first reduced to CO, then to CH₄ and on to other hydrocarbons. A 3:1 ratio of gold to copper results in the largest amount of hydrocarbon product.

More information: "Photocatalytic Reduction of Carbon Dioxide by Hydrated Hydrazine over Au–Cu Alloy Nanoparticles Supported on SrTiO₃/TiO₂ Coaxial Nanotube Arrays." *Angew. Chem. Int. Ed.*

doi: 10.1002/anie.201409183

Provided by Angewandte Chemie

Citation: Efficient catalytic system for the photocatalytic reduction of CO₂ to hydrocarbons (2014, December 5) retrieved 11 September 2024 from <https://phys.org/news/2014-12-efficient-catalytic-photocatalytic-reduction-co2.html>

This document is subject to copyright. Apart from any fair dealing for the purpose of private study or research, no part may be reproduced without the written permission. The content is provided for information purposes only.