NEWS

EXSYN
ESSENTIAL CHEMISTRY

Novel Photocatalyst Effectively Turns Carbon Dioxide Into Methane Fuel With Sunlight :

Carbon dioxide (CO_2) is one of the major greenhouse gases causing global warming. If carbon dioxide could be converted into energy, it would be killing two birds with one stone in addressing the environmental issues. A new photocatalyst is developed recently, which can produce methane fuel (CH_4) selectively and effectively from carbon dioxide using sunlight. According to this research, the quantity of methane produced was almost doubled in the first 8 hours of the reaction process.

The research was conducted collaboratively by Australia, Malaysia, and the United Kingdom.

Inspired by the photosynthesis in nature, carbon dioxide can now be converted effectively into methane fuel by the newly designed solar-powered catalyst, which will lower carbon emission. Furthermore, this new catalyst is made from copper-based materials, which is abundant and hence affordable.

It is found that cuprous oxide (Cu_2O), a semiconducting material, has been applied as both photocatalyst and electrocatalyst to reduce carbon dioxide into other chemical products like carbon monoxide and methane in different studies. However, it faces several limitations in the reduction process, including its inferior stability and the non-selective reduction which causes the formation of an array of various products. Separation and purification of these products from the mixture can be highly challenging and this imposes technological barrier for large scale application. Furthermore, cuprous oxide can be easily corroded after brief illumination and evolve into metallic copper or copper oxide.

To overcome these challenges, a novel photocatalyst is synthesized by enwrapping cuprous oxide with copper-based metal-organic frameworks (MOFs). Using this new catalyst, pure methane gas can selectively be produced. When compared with cuprous oxide without MOF shell, cuprous oxide with MOF shell reduced carbon dioxide into methane stably under visible-light irradiation with an almost doubled yield. Also, cuprous oxide with MOF shell was more durable and the maximum carbon dioxide uptake was almost seven times of the bare cuprous oxide.

Moreover, the research team discovered that the cuprous oxide was stabilized by the conformal coating of MOF. The excited charges in cuprous oxide upon illumination could efficiently migrate to the MOF. In this way, excessive accumulation of excited charges within the catalyst, which could lead to self-corrosion, was avoided. Hence extended the catalyst's lifetime.

The next step will be to further increase the methane production rate and explore ways to scale up both the synthesis of the catalyst and the reactor systems. In the entire process of converting carbon dioxide to methane, the only energy input we have used was sunlight. We hope in the future, carbon dioxide emitted from factories and transportation can be 'recycled' to produce alternate fuels.

Reference:

Angewandte Chemie, titled "Metal-Organic Frameworks Decorated Cuprous Oxide Nanowires for Long-lived Charges Applied in Selective Photocatalytic CO2 Reduction to CH4"