New catalyst turns ammonia into an innovative clean fuel

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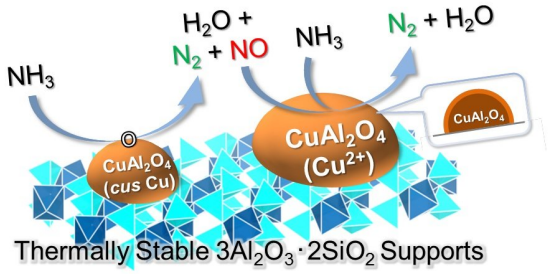

CuOx/3A2S selectively produces N_2 and H_2O from NH_3 through a two-step reaction. Credit: Dr. Satoshi Hinokuma

Taking measures against climate change and converting into societies that use significant amounts of renewable energy for power are two of the most important issues common to developed countries today. One promising technology in those efforts uses hydrogen (H_2) as a renewable energy source. Although it is a primary candidate for clean secondary energy, large amounts of H_2 must be converted into liquid form, which is a difficult process, for easier storage and transportation. Among the possible forms of liquid H_2, ammonia (NH_3) is a promising carrier because it has high H_2 density, is easily liquefied, and can be produced on a large-scale.

Additionally, NH_3 has been drawing attention recently as a carbon-free alternative fuel. NH_3 is a combustible gas that can be widely used in thermal power generation and industrial furnaces as an alternative to gasoline and light oil. However, it is difficult to burn (high ignition temperature) and generates harmful nitrogen oxides (NOx) during combustion.

Researchers at the International Research Organization for Advanced Science and Technology (IROAST) in Kumamoto University, Japan, focused on a "catalytic combustion method" to solve the NH_3 fuel problems. This method adds substances that promote or suppress chemical reactions during fuel combustion. Recently, they succeeded in developing a new catalyst which improves NH_3 combustibility and suppresses the generation of NOx. The novel catalyst (CuOx/3A2S) is a mullite-type crystal structure $3Al_2O_3 \cdot 2SiO_2$ (3A2S) carrying copper oxide (CuOx). When NH_3 was burned with this catalyst, researchers found that it stayed highly active in the selective production of N_2, meaning that it suppressed NOx formation, and the catalyst itself did not change even at high temperatures. Additionally, they succeeded with *in situ* (*Operando*) observations during the CuOx/3A2S reaction, and clarified the NH_3 catalytic combustion reaction mechanism.

Since 3A2S is a commercially available material and CuOx can be produced by a method widely used in industry (wet impregnation method), this new catalyst can be manufactured easily and at low cost. Its use allows for the decomposition of NH_3 into H_2 with the heat from (low ignition temperature) NH_3 fuel combustion, and the purification of NH_3 through oxidation.

"Our catalyst appears to be a step in the right direction to fight anthropogenic climate change since it does not emit greenhouse gasses like CO_2 and should improve the sophistication of renewable energy within our society," said study leader Dr. Satoshi Hinokuma of IROAST. "We are planning to conduct further research and development under more practical conditions in the future."

This research was posted online in the *Journal of Catalysis* on 26 March 2018.

More information: Satoshi Hinokuma et al, Catalytic ammonia combustion properties and operando characterization of copper oxides

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