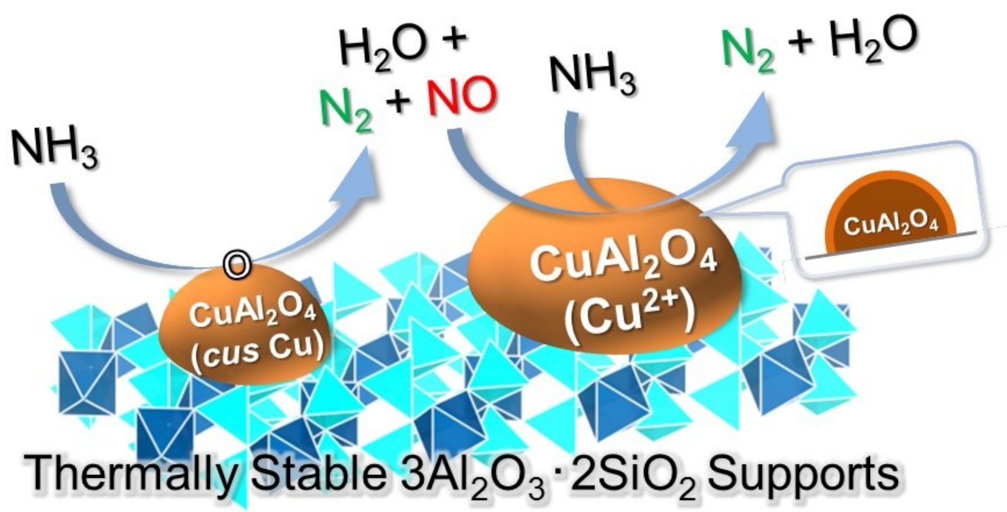
# New catalyst turns ammonia into an innovative clean fuel

April 30 2018




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 supported on aluminum silicates and silicon oxides, *Journal of Catalysis* (2018). DOI: 10.1016/j.jcat.2018.03.008

Provided by Kumamoto University