New catalyst could improve biofuels production

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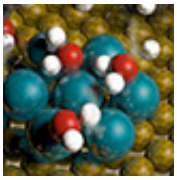

The October 2014 cover of ACS Catalysis shows a palladium-iron catalyst and its ability to remove oxygen from m-cresol, which is a model compound for lignin. Credit: Cortland Johnson, PNNL.

Washington State University researchers have developed a new catalyst that could lead to making biofuels cheaply and more efficiently.

Led by Voiland Distinguished Professor Yong Wang, the researchers mixed inexpensive iron with a tiny amount of rare palladium to make the catalyst. Their work was featured on the cover of the October issue of the journal *ACS Catalysis*.

Removing oxygen for better fuel

Researchers, government leaders and industry leaders are interested in renewable biofuels as a way to reduce national dependence on fossil fuels and reduce emissions of harmful carbon dioxide to the atmosphere, where it contributes to global warming.

One of the biggest challenges in biofuels production is grabbing carbon for fuel while also removing oxygen. High oxygen content makes biofuel less stable, gooier and less efficient than fossil fuels and not suitable for airplane or diesel fuels. To improve production, researchers also want to use as little hydrogen as possible in the reaction.

The WSU researchers developed a mixture of two metals, iron along with a tiny amount of palladium, to serve as a catalyst to efficiently and cheaply remove oxygen.

"The synergy between the palladium and the iron is incredible," said Wang, who holds a joint appointment with Pacific Northwest National Laboratory and WSU. "When combined, the catalyst is far better than the metals alone in terms of activity, stability and selectivity."

Palladium makes iron work better

Iron catalysts have been an inexpensive way to remove oxygen from plant-based materials. But the catalyst can stop working when it interacts with water, which is a necessary part of biofuels production. The iron rusts.

Palladium can work in water, but it is not terrific at removing oxygen; and the metal is very expensive.

The researchers found that adding extremely small amounts of palladium to iron helped cover the iron surface of the catalyst with hydrogen, which caused the reaction to speed up and work better. It also prevented water from interrupting the reactions. And less hydrogen was needed to remove the oxygen.

"With biofuels, you need to remove as much oxygen as possible to gain energy density," said Wang. "Of course, in the process, you want to

minimize the costs of oxygen removal. In this case, you minimize hydrogen consumption, increase the overall activity and gain high yields of the desired fuel products using much less expensive and more abundant catalyst materials."

WSU teams collaborate

The team used advanced techniques – including high-resolution transmission electron microscopy, X-ray photoelectron spectroscopy and extended X-ray absorption fine structure spectroscopy – to understand how atoms on the catalyst's surface interact with the plant material lignin. Corresponding theoretical calculations were done by a WSU team led by Jean-Sabin McEwen.

"By adding the palladium, we could potentially use metals such as iron, which are cheaper and abundant while functioning at better rates with higher yields than palladium or iron alone," said Wang.

The researchers would like to extend their studies under more realistic conditions that more closely mimic real biofuels production.

Provided by Washington State University

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