

## Catalytic Upgrading of Bioderived Alcohols to Sustainable Aviation Fuel (SAF)

Meijun Li<sup>1</sup>, Stephen Purdy<sup>1</sup>, Aibolat Koishybay<sup>1</sup>, Zhenglong Li<sup>1</sup>, Brian Davison<sup>1</sup> ([davisonbh@ornl.gov](mailto:davisonbh@ornl.gov)), Andrew Sutton<sup>1</sup> ([suttonad@ornl.gov](mailto:suttonad@ornl.gov)) and **Gerald A. Tuskan**<sup>1</sup>

<sup>1</sup>Center for Bioenergy Innovation, Oak Ridge National Laboratory

[cbi.ornl.gov](http://cbi.ornl.gov)

**Project Goals: The Center for Bioenergy Innovation (CBI) vision is to accelerate domestication of bioenergy-relevant, non-model plants and microbes to enable high-impact innovations at multiple points in the bioenergy supply chain. CBI addresses strategic barriers to the current bioeconomy in the areas of 1) high-yielding, robust feedstocks, 2) lower capital and processing costs via consolidated bioprocessing (CBP) to specialty biofuels, and 3) methods to create valuable byproducts from the lignin. CBI will identify and utilize key plant genes for growth, composition, and sustainability phenotypes as a means of achieving lower feedstock costs, focusing on poplar and switchgrass. We will convert these feedstocks to biofuels using CBP with cotreatment at high rates, titers and yield in combination with catalytic upgrading into drop-in hydrocarbon fuel blendstocks.**

Upgrading small bioderived alcohols to Sustainable Jet Fuel (SAF) is one promising alcohol-to-jet pathway as the olefin intermediates can be readily converted to jet-range hydrocarbons with high selectivity. We have shown that using the zeolite H-ZSM-5 we can convert butanol to butenes with near quantitative conversion at 225 °C and ambient pressure, where 1-butene is the dominating fraction among butene isomers.<sup>1</sup> The olefins were further oligomerized into longer-chain hydrocarbons over Amberlyst-36 catalyst at 150 °C and 15 bar, leading to 70% of jet, 12% of gasoline and 10% of diesel fractions. Recently we have modified the catalyst by incorporating copper with zinc<sup>2</sup> and lanthanide metals which allows us to tailor the olefin composition and conversion efficiencies to enable us to determine the optimal conditions to maximize the carbon we can incorporate in the resultant SAF. This also inhibits ethylene formation which is not conducive to higher olefin formation and allows for > 90% selectivity to C<sub>4+</sub> olefins. Preliminary catalyst stability has been evaluated with over 200 hours on stream and regeneration of the catalyst performed successfully over this period. We have also investigated the relationship between Lewis acid sites and alcohol dehydrogenation and C-C bond formation activity. We are currently determining the role of metal distribution on deactivation and subsequent regeneration and how these effects are influenced by the choice of lanthanide metal.

### References/Publications

1. Yuk S., Lee M-S., Collinge G., Zhang J., Padmaperuma A. B., Li Z., Polo-Garzon F., Wu Z., Glezakou V-A., Rousseau R., *J. Phys. Chem. C.*, 2020, 124, 52, 28437
2. Zhang J., Wegener E. C., Samad N. R., Harris J. W., Unocic K. A., Allard L. F., Purdy S., Adhikari S., Cordon M. J., Miller J. T., Krause T. R., Cheng S., Liu D., Li M., Jiang X., Wu Z., Li Z., *ACS Catal.*, 2021, 11, 15, 9885

*The Center for Bioenergy Innovation is a U.S. Department of Energy Bioenergy Research Center supported by the Office of Biological and Environmental Research in the DOE Office of Science.*