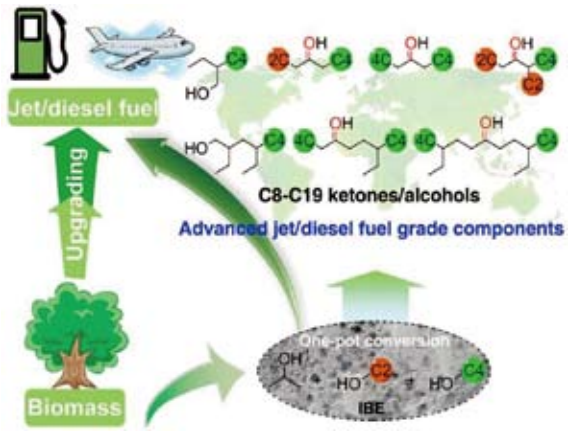
Produce Sustainable Jet, Diesel Fuels from Biomass with Novel Catalysts

You may know that the gasoline sold at gas stations contains certain percentages of ethanol (C2) as an additive. However, long-chain alcohols (C4-C19) are regarded as better alternatives for ethanol in gasoline or jet/diesel fuels. These higher alcohol dopants can be produced from short-chain ones (such as methanol, ethanol and propanol), and sustainable biomass resources like straw or wood residues can be utilized to get lower alcohols via fermentation, a process widely used in brewery since long time ago.

Recently, a group of researchers from the Qingdao Institute of Bioenergy and Bioprocess Technology of CAS has developed novel catalysis routes to convert low alcohols to higher ones.

To produce jet fuel (mainly C9-C16) additives for airplanes, first of all, they screened and designed an efficient metal/carbon catalyst, with palladium as active component, for the highly selective transformations. Then, they used novel palladium catalyst to obtain long-chain (C8-C19) alcohols or ketones (with similar structure to alcohols), which are components for renewable jet/diesel fuel, with over 90% selectivity. Notably, the catalytic system showed high stability and recyclability under hydrothermal reaction conditions.

This study is the first report on the direct upgrading of short chain alcohol mixtures (isopropanol-butanol-ethanol or combined with biomass-derived alcohols). Through control experiments and catalyst characterization, the researchers speculated that the high selectivity may have originated from the promotion of butanol self-condensation and consecutive activation of C7 and C8 intermediates for further condensation over palladium metal.



Scheme for sustainable jet/diesel fuels production from biomass.

Their work has been published in ChemSusChem.

Another work from the same group focused on the condensation of two kinds of low alcohols, methanol and bio-ethanol, to produce a higher alcohol called isobutanol, a C4 alcohol, with an iridium/carbon catalyst. The isobutanol selectivity can reach as high as 90%. The branched-chain isobutanol has higher octane numbers (a standard measure of the performance of a fuel) than its straight chain counterpart. The catalyst system also exhibited good water tolerance, which is a key factor to be considered for future industrial application. This study was published in Green Chemistry.