Production of Advanced Biofuels for Blending into Jet and Diesel Fuels via Furanic Intermediates

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Carbohydrates from lignocellulosic biomass represent an abundant source of carbon that can be transformed into transportation fuel precursors through cellulose and hemicellulose depolymerization and hydrolysis to C5 and C6 sugars. Dehydration of the sugars under acidic conditions results in formation of furfural and 5-hydroxymethylfurfural, which can then be used in carbon chain extension reactions to form oxygenated precursors to jet- and diesel-range fuels. There has been significant on-going interest in developing carbon-carbon coupling routes for such sugar-derived furans.

The main purpose of our work has been to develop catalytic transformation routes that more efficiently upgrade sugar-derived intermediates into fuel products or value-added co-products. The fuel products are hydrocarbons with excellent properties for blending in jet and diesel fuels (cetane number 74, boiling point 254 ^{o}C, and a freezing point below -80 ^{o}C giving it very good Cloud Point properties). This research, therefore, directly supports the DOE's Bioenergy Technology Office's goals to demonstrate conversion of sugars into hydrocarbons that can be used as advanced drop-in biofuels.

Furfural is a useful intermediate as it is readily formed from the pentoses in biomass by acid catalyzed dehydration and can be converted into methylfuran in high yield under moderate reaction conditions. Methylfuran will then readily undergo acid catalyzed condensation with aldehydes that can be obtained from renewable resources, including a 4-oxopentaldehyde that can be generated from itself. We have demonstrated several of these reactions at the bench scale and then converted the oxygenated intermediates into hydrocarbons in the C12 to C16 range. Overall yields of hydrocarbons can exceed 60 mole% from the starting sugar. This presentation will describe production of the intermediates and the characteristics of the hydrocarbon products we have obtained.