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Catalytic Conversion of Bioproducts to Fuels

Environmental and political issues created by our dependence on fossil fuels, such as global warming and national security, combined with diminishing petroleum resources are causing our society to search for new renewable sources of energy and chemicals, and an important sustainable source of organic fuels, chemicals and materials is plant biomass. We present results for catalytic production of liquid fuels by catalytic conversion of biomass-derived oxygenated hydrocarbons, such as glycerol, sorbitol, and glucose. We show how gas mixtures of H_2 and CO (synthesis gas) can be produced at high rates and selectivities from glycerol over platinum-based bi-metallic catalysts at temperatures (*e.g.*, 500-620 K) that are significantly lower compared to conventional gasification of biomass, allowing this gasification step to be coupled effectively with hydrocarbon production by Fischer-Tropsch synthesis. We also report an integrated catalytic approach for the conversion of sorbitol and glucose to targeted classes of hydrocarbons for use as liquid transportation fuels. This approach is based on the integration of two flow reactors operated in a cascade mode, where the effluent from the first reactor is fed to the second reactor, and can be tuned either for production of highly branched hydrocarbons and aromatic compounds in gasoline, or for production of longer chain, less highly branched hydrocarbons in diesel and jet fuels. This two-reactor approach provides further processing flexibility because the effluent stream from the first flow reactor produces a liquid organic stream containing mono-functional compounds, such as alcohols, ketones, carboxylic acids, and heterocycles that can also be used to provide reactive intermediates for the lower-volume, but higher value, fine chemicals and polymers markets. Finally, we will show how hydroxymethylfurfural (HMF) can be formed in high yields by dehydration of carbohydrates in a biphasic reactor, and we illustrate how HMF can subsequently be used to produce liquid transportation fuels, such as dimethylfuran and alkanes ranging from C_8 to C_{15}.