UNIVERSITY OF SOUTH FLORIDA

Production of Liquid Fuels Biomass via Thermo-Chemical Conversion Processes

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Description: The objective of this project is to develop technology for the economical thermo-chemical conversion of lingocellulosic biomass (non-food grade biomass such as agricultural waste, bagasse from sugar mills, citrus peels, switch grass, municipal green waste, etc.) to clean burning liquid fuels. Five of the major advantages of this process over a biochemical route to production of ethanol are: (i) it does not utilize food-grade feed stocks and therefore complements and does not compete with the agricultural food production in the state, (ii) the fuel produced is similar to those derived from petroleum unlike ethanol derived fuels which have at least a 25% lower energy content, (iii) the conversion is accomplished in using fast chemical reactions unlike the slow biological reactions for fermenting alcohol, (iv) the process does not require large amounts of water and associated energy costs of separating the water from the fuel as in bioethanol processes, (v) it can utilize a wide variety of biomass sources unlike the biochemical route which cannot work with high lignin containing biomass.

Budget: $554,447

Universities: USF

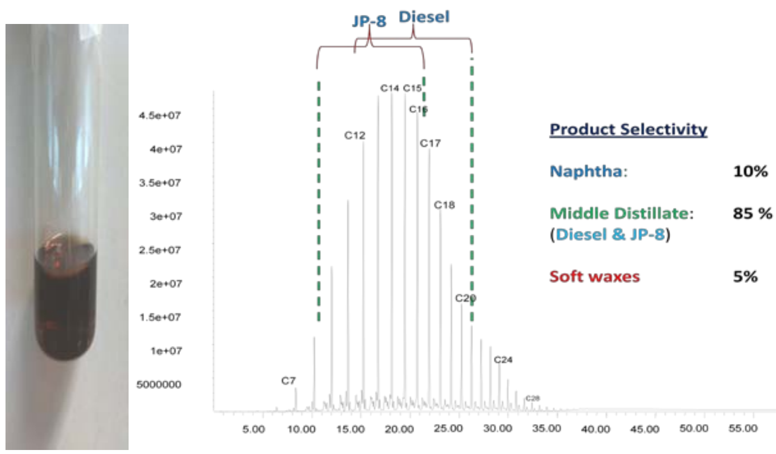
External Collaborators: Prado & Associates

Progress Summary

During the past six months, we made progress on four fronts: Biomass conversion process design, Reactor testing for synthesis of liquid fuels from bio syngas, catalyst synthesis and catalyst testing.

In the area of process design, we have been evaluating alternative strategies to combine the energy intensive biomass gasification step with the energy producing Fisher-Tropsch synthesis of clean liquid fuels from syngas produced in the gasification step. We are exploring ways of recycling energy by using the methane off gas produced in the FTS to fuel the steam pyrolysis of biomass. Another avenue we are exploring is a novel strategy to combine solar thermal powered steam pyrolysis with the syngas production step.

We successfully tested egg-shell catalysts in our fixed bed reactor setup using both mixtures of CO and H2 as well as Biosyngas produced from poplar wood. The product liquid produced have been analyzed and report good yield in the diesel and jet fuel range. The figure below shows sample of fuel made and its chemical composition.



We also continue with our catalyst characterization process. We are continuing to study the mechanisms of CO dissociation on the catalyst surface using density functional theory calculations. Current focus of this effort is on the effect of catalyst nanoparticle size on the adsorption and dissociation energies.

Catalyst synthesis efforts continue. We have successfully synthesized cobalt nanoparticles and placed them on silica Microparticles. These are currently being characterized and tested for activity.

Our DFT study focuses on the influence of cobalt particle size on CO adsorption and the effect of platinum promoter on the reduction of cobalt in a CoPt bimetallic catalyst. Cobalt catalysts exhibit particle size dependent activity. CO adsorption was studied, as it is the rate-limiting step in Fischer-Tropsch reaction. Studies on the effect of cobalt particle size on CO adsorption showed particle size dependence. Facets cut from a model icosahedral nanocluster was used for this purpose and two different adsorption sites, face centered cubic (fcc) and hexagonal closed packed (hcp) sites were explored depending on the size of the cluster. Back-donation of electrons from cobalt to carbon atoms was observed along with the weakening of CO bond length.