Environmental Science
& Policy Program
at Michigan State University

ESPP Research Colloquia Series Spring 2017

Thermochemical Conversion and Electrochemical Upgrading of Biomass to Displace Fossil Fuels and Provide Carbon Sequestration Strategies

Mahlet Garedew

(Biosystems & Agricultural Engineering and ESPP)

With current energy crisis and the implication of fossil fuel use on climate change, energy production from biomass using fast pyrolysis offers an alternative way to produce liquid transportation fuels and provide carbon sequestration strategies. Fast pyrolysis is a thermochemical approach in which biomass is liquefied by heating in the absence of oxygen to form pyrolysis gas and biochar. Most of the pyrolysis gas can be condensed to liquid "bio-oil" with a bulk density greater than that of the feedstock. Biomass densification near the harvest source reduces the cost of transportation and storage prior to upgrading in a central refinery. But before bio-oil can be used as a transportation fuel, energy and stability upgrading via electrocatalytic hydrogenation and deoxygenation is needed. The mild nature of electrocatalysis makes it more attractive than current catalytic hydrogenation schemes that require relatively high temperature and pressure. In addition to being co-fired with coal for heat and power production, biochar has potential for soil amendment and carbon sequestration. Compared to crop residue left on land, biochar has more recalcitrant carbon that might take several years to degrade thus making it a good candidate for long-term carbon sequestration. The non-condensable gas produced during pyrolysis can be burned for process heat thus providing the energy needed to power pyrolysis reactors. This study specifically focuses on electrocatalytic upgrading of bio-oil model compounds derived from lignin to improve storage stability and energy content. As lignin comprises up to 30 wt% and 40% of the energy of biomass, processes such as pyrolysis that can derive fuels and value-added products from lignin are highly favorable. To date, several lignin-derived bio-oil model compounds have been reduced to simpler compounds such as cyclohexanol and phenol using ruthenium on activated carbon (Ru/ACC) as a catalyst. The coupling of pyrolysis and electrocatalysis for upgrading lignins that are byproducts of other conversion processes, will enable the maximization of yields from biomass conversion in addition to having an environmentally friendly and sustainable way of converting biomass to fuels and value-added products.

2 p.m. - 4 p.m. Friday March 17, 2017
273 Giltner Hall
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