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Lignin Based Ion Conducting Materials for Energy Conversion/Storage Device

Abstract.
Lignocellulosic biorefineries and pulp and paper industries produce lignin rich waste (> 70 million ton/yr) that is usually burned to generate heat. Only a small fraction of this lignin is utilized to produce value-added chemicals. The success of future biorefineries greatly relies on efficient utilization of lignin as value-added products. In an effort along that direction, this project will explore an innovative approach towards utilization of lignin as a coproduct of biorefineries using lignocellulosic biomass to produce ion conducting polymers (ionomers). Our preliminary data suggests that lignin, with ion conducting functionalities, can be used as low-cost, environment friendly, and efficient ionomers for membrane separators, and catalyst binder materials for energy conversion and storage devices (fuel cells, batteries, supercapacitors). This NCESR project will selectively fractionate lignin from local feedstock (such as corn stover and eastern redcedar) using innovative and less harsh techniques to minimally alter the chemical structure of native lignin. The neutral polymer, after characterization, will be rendered ion conducting functionalities to yield ionomers with controlled ion exchange capacity (IEC) and water solubility. The role of chemical structure and IEC of lignin based ionomers on nanoscale self-assembly, ionic domain characteristics, viscoelasticity, ion conductivity, and ion permselectivity will be explored systematically in sub-micron thick films and bulk free-standing membrane format. By exploring innovative approaches for co-utilization of waste lignin from biorefineries, we can positively impact the local, national and global bioeconomy as well as the energy economy.