# ELECTROCATALYTIC PROCESSING OF BIORENEWABLES FOR GENERATION OF ELECTRICITY, CHEMICALS AND FUELS

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Biomass is abundant, inexpensive and renewable, therefore, it is highly expected to play a significant role in our future energy and chemical landscapes. The US-DOE has identified some platform compounds (or building blocks, i.e. glycerol, levulinic acid, furfural, etc.) that can be readily derived from biomass, and currently the chief research need is to develop cost-effective, green and sustainable approaches to utilize these biorenewable feedstock. I will present our recent research progress in exploration of aqueous phase electrocatalytic processing of the biomass platform compounds for generation of electricity, chemicals and fuels. We investigated electrocatalytic selective oxidation of polyols for cogeneration of higher-valued chemicals and electricity, and discovered that the degree of glycerol oxidation on Au nanoparticles can be well tuned with anode potential to produce tartronate (oxidizing two primary –OH, ≥ 0.35 V), mesoxalate (oxidizing three –OH, ≥ 0.45 V) or glycolate (breaking C-C bond, ≥ 0.9 V). DFT calculation on electro-oxidation of 1,2 propanediol over Au (111) was performed to explain the electrode potential effect of selective oxidation of polyols. Our work may open a new route for the controllable transformation of biomass compounds with poly- or multi-functional groups into valuable chemicals. We developed a direct crude glycerol (88%) anion-exchange membrane fuel cell with self-prepared carbon nanotube supported surface dealloyed PtCo nanoparticle anode catalyst (0.5 $mg_{Pt}$ $cm^{-2}$) and commercial Fe-based cathode catalyst, which demonstrated a record high output peak power density of 268 mW $cm^{-2}$ (at 80 $^{o}C$ and ambient pressure) and decent operation stability and system durability. We also explored electrocatalytic processes to store renewable electricity in biofuels / biofuel additives, and have demonstrated electrocatalytic hydrogenation (ECH) of levulinic acid (LA) to higher energy-density biofuel intermediates: valeric acid (VA) or γ-valerolactone (gVL) on non-precious Pb electrode with high yield and faradaic efficiency in a single electrolysis flow cell reactor. The applied potential and electrolyte pH were found to control the product distribution. It is interesting that formic acid (co-produced with LA in cellulose hydrolysis stream) can increase the rate of ECH of LA to VA. Our recent research in Cu foil with nanostructured surface for efficient ECH of furfural to methyl furan biofuel additives and photoelectrolysis of hydroxymethylfurfural (HMF) to biopolymer precursor furandicarboxylic acid (FDCA) will also be briefly presented.