# Biocrude Derived Anode Material Production for Lithium-ion Batteries

Shaikat Chandra Dey[1], Md. Nazrul Islam[1], Jose A. Gonzalez-Aguirre[1], Ravindra Kumar Bhardwaj[2], Bertrand J. Tremolet de Villers[2], Brian J. Worfolk[3], William Joe Sagues[4], Steven M. Rowland[5], Mark R. Nimlos[5], Sunkyu Park[1]*

[1]Department of Forest Biomaterials, North Carolina State University, Campus Box 8005, Raleigh, NC 27695
[2]Materials, Chemical, and Computational Science Directorate, National Renewable Energy Laboratory, 15013 Denver West Parkway, Golden, CO 80401
[3]Worfolk Consulting, Raleigh, NC 27610
[4]Department of Biological and Agricultural Engineering, North Carolina State University, 3110 Faucette Dr., Raleigh, NC 27695
[5]Bioenergy Science and Technology Directorate, National Renewable Energy Laboratory, 15013 Denver West Parkway, Golden, CO 80401

*Corresponding author (sunkyu_park@ncsu.edu)

## Abstract

The catalytic graphitization of pyrolysis bio-oil using iron (Fe) can yield anode material for lithium-ion batteries (LIBs) at moderate temperatures. The primary obstacle to scaling up the process is the foaming resulting from the oxidation of iron by the organic acids in bio-oil. This study investigated five distinct pathways for mitigating foaming in bio-oil following the addition of iron, comprising (i) the application of defoamers, (ii) the utilization of iron oxide ($Fe_2O_3$) as a graphitization catalyst, (iii) the adjustment of bio-oil pH, (iv) bio-oil coking at temperatures between 300-500 °C, and (v) low-temperature pretreatment of bio-oil at 150-200 °C. The low-temperature pretreatment effectively prevented foaming by eliminating the volatile acids in bio-oil, facilitated the uniform mixing of solidified bio-oil powder with the Fe catalyst. The biographite, catalytically synthesized at 1500 °C following the pretreatment method, exhibited an almost theoretical specific gravimetric capacity (~370 mAh/g), a high initial Coulombic efficiency (90.03%), and minimal capacity loss after 50 cycles in LIB half-cells. The low-temperature pretreatment method also addressed the viscosity, swelling, and aging challenges related to bio-oil processing, hence facilitating more feasible scale-up efforts.