



 Sunkyu Park, Ph.D.  
working in the lab at NCSU.

MARC HALL, NCSU

# The Search for Sustainable Carbon Materials

## Using the Loblolly Pine to Move Away from a Fossil-Based Economy

BY AMANDA MURPHY, DIRECTOR OF COMMUNICATIONS

**R**ecently, I had the pleasure of partnering with our local land grant university, North Carolina State University (NCSU), to share details about important research taking place in the Department of Forest Biomaterials. I spoke with Sunkyu Park, Ph.D., an E.J. “Woody” Rice Associate Professor & University Faculty Scholar, about the interesting topic of using forestry biomass for energy.

Dr. Park had a recent opportunity to present his research on manufacturing carbon materials in the lab at NCSU. Dr. Park’s group has received \$5.5 million in funding from the Department of Energy, which has enabled him to work with several industry partners and a national lab to make graphite from natural resources like the loblolly pine on a pilot scale. It is a 4.5-year project and will be kicking off in the next two to three months.

### Q What are carbon materials, and how were they used in your research?

Carbon materials are products consisting of carbon elements. Depending on how carbon is arranged (e.g., nano-scale structure, density, size, surface area), different types of carbon materials are created in the market, including biochar, activated carbon, graphite, diamond, and graphene.

Our group first had to gain a deeper understanding of biochar, then moved on to researching activated carbon, and finally to researching and manufacturing graphite. As you go down the list of materials, each one is more expensive and of higher quality than the next.

### Q What prompted you to research this topic, specifically?

Materials like natural graphite come from fossil resources, and thus, there are numerous environmental issues, including a lack of sustainability. Our number one motivation was to develop a technology for fuels, chemicals, and materials from naturally occurring biomass, to replace those materials that come from petroleum.

### Q How can this research be used in functional day-to-day activities?

Have you seen a Tesla? The lithium-ion batteries they have created are the biggest market in the near future for energy storage. These batteries can be recharged hundreds of times and are more stable than other batteries. They tend to have a higher energy density and lower self-discharge rate than other rechargeable batteries. This makes for better power efficiency, as a single cell has a longer charge retention than other battery types. There are many other industries using graphite, such as fuel cells, nuclear reactors, and refractories.

#### BIOCHAR

Least Expensive  
Lowest Quality

#### ACTIVATED CARBON

More Expensive  
Higher Quality

#### GRAPHITE

Most Expensive  
Highest Quality



## Q How is graphite typically created?

Natural graphite is mined from geographically constrained natural deposits and subsequently purified using a series of energy- and chemical-intensive processes. Purification of natural graphite typically involves toxic chemicals, which might cause damage to both public health and the environment. Synthetic graphite is typically produced by processing low-sulfur petroleum distillation residues via a delayed coking operation at ~1,500 °C to form needle coke, which is then graphitized at ~2,500 °C for over a week. Currently, ~80% of graphite comes from mining and ~20% comes from petroleum residue.

## Q Why/how are you using loblolly pine to create graphite, and what are the benefits of using loblolly instead of traditional materials?

The reason we chose loblolly is that number one, it is abundant in our local area around NCSU; and number two, it is a reasonably consistent material in terms of its chemistry, which makes it a great material for mature development.

## Q What is the goal of your research into graphite from loblolly pine, and why is it important?

The goal of graphite production from loblolly pines is to compete with commercial graphite (natural and synthetic graphite). At this moment, the quality of graphite from loblolly pine is not as high as commercial graphite. However, we are hoping to develop technology and overcome the quality issue in the coming years.

## Q What are the main takeaways from your research?

My main research takeaway is the importance of moving away from a fossil-based economy. We want to develop environmentally sustainable technology to create a more robust bio-economy.

**RESEARCH:** A simple method for producing bio-based anode materials for lithium-ion batteries, W.J. Sagues, J. Yang, N. Monroe, S. Han, T. Vinzant, M. Yung, H. Jameel, M. Nimlos, S. Park. *Green Chemistry*, 22: 7093-7108 (2020). Publication Date: September 29, 2020. <https://doi.org/10.1039/D0GC02286A>. Copyright © 2020 Royal Society of Chemistry



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