Green Synthesis of Phosphorous, Nitrogen Co-Doped Carbon Materials from Renewable Resources for Supercapacitor Applications via Microwave Assisted Technique

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We heavily depend on petroleum for energy production, petroleum-based polymer synthesis and the manufacturing of multiple important chemicals. More than 95% of the energy in the United States is still provided by fossil fuels, nuclear power and traditional hydropower. Based on the current pace of utilization and the rapid population growth, it is predicted that the remaining fossil fuel reserves are likely to deplete within the next few decades. Supercapacitors are gaining importance in energy storage applications due to their portability, long cycle lifetime, high energy density, and power density. Fundamentally, the performance of these supercapacitors has a direct relationship to the properties of materials used in their development. The first research goal of this experiment was to utilize inexpensive natural resources such as Tannins, Tea, and Molasses as a precursor for carbon and dope them with heteroatoms to develop Phosphorous, Nitrogen co-doped carbon biomaterials for the development of supercapacitors. The second research goal was to use a microwave technique to synthesize the samples in a one-pot reaction. The results suggested that the Tannin/Hexamine/Melamine/AP sample displayed the highest overall capacitance (183 F/g), with the highest surface area (724.75 m2/g), good pore diameter (3.02 nm), and a low amount of micropores (0.07 cm3/g) which all ultimately led to the best sample for the development of supercapacitors. Conversely, the Tea/PPA/melamine sample had a surface area of 129.07 m2/g, a poor pore diameter value (4.58 nm), and a micropore value of 0.02 cm3/g which made up a third of the total pore volume (0.08 cm3/g) which explains the lower capacitance values (18 F/g).

Awards Won:

Intel ISEF Best of Category Award of $5,000

First Award of $5,000

Intel Foundation Young Scientist Award

American Chemical Society: Certificate of Honorable Mention