In this dissertation, nano cerium oxide (nano CeO2) based materials are examined as an active material for supercapacitor applications. The first part of this work details how the morphology and selective crystal planes can lead to significantly improved charge storage; and how a combination of high surface area and exposure of high energy crystal planes (\{110\}, \{100\}) can lead up to 1.5 times higher charge storage capacity. The remainder of the thesis examines how nano CeO2 can effectively be used as an additive to improve the electrochemical properties of other supercapacitor materials. The second part describes a method to drastically improve the poor cycle life of conductive polymer-based materials by the addition of nano CeO2 and graphene through scalable spraydrying process. The ternary composite exhibits a high energy density (46.3 Wh Kg\(^{-1}\)) and stable cycle life (92% capacitance retention after 6000 cycles). The third part details how nano CeO2 can be used as an active mechanical spacer for graphene aerogel based material. Here, nano CeO2 not only contributes towards charge storage but also prevents the restacking of graphene layers. The hybrid aerogels exhibit a high specific capacitance of 503 F g\(^{-1}\) and minimal capacitance fade after 10,000 cycles. This work highlights how engineering nanostructures beyond simple size reduction can lead to superior electrochemical properties and ultimately EEDs with improved safety, high power, and energy density.

Major: Materials Science and Engineering

Educational Career:
Bachelor's of Mechanical Engineering, BS, 2012, Anna University
Master's of Materials Science and Engineering, MS, 2015, University of South Florida

Committee in Charge:
Sudipta Seal, Chair, Materials Science and Engineering
Raj Vaidyanathan, Materials Science and Engineering
Linan An, Materials Science and Engineering
Alfons Schulte, Department of Physics
Swaminathan Rajaraman, NanoScience Technology Center
Tengfei Jiang, Materials Science and Engineering

Approved for distribution by Sudipta Seal, Committee Chair, on March 20, 2020.

The public is welcome to attend.