Ultra-Thin Asymmetric Supercapacitor: Utilizing Nano-Porous Nickel and Graphene-Copper for a High Energy Density

Mancevski, Alexander

Supercapacitors are important because of their increasing role in powering many mobile, wearable and medical devices that help and improve peoples' lives. Supercapacitors can store energy with electrostatic reactions, such as in electric double-layer capacitors (EDLCs) made from carbon materials, or they can store energy based on faradaic reactions such as in redox supercapacitors made from transition metal oxides and hydroxides. My project explores novel redox supercapacitor materials, and in particular research on nano-porous nickel supercapacitors. My innovation is to combine graphene grown on copper as the cathode with nano-porous nickel as the anode in an asymmetric supercapacitor. The porous nickel is electrochemically etched from the nickel foil electrode, and as a result it has larger capacitance and a lower manufacturing cost than conventional supercapacitors. The resulting asymmetric redox-supercapacitor has higher capacitance and capacity as compared to thin nano-porous nickel redox supercapacitors and thin carbon based EDLC supercapacitors. The combination of asymmetric nano-porous nickel and copper-graphene electrodes also allows for higher operating supercapacitor voltage, up to 1.8 Volts. In addition, my redox-supercapacitor discharges with a battery-like flat voltage plateau, making it usable for applications that require sustained voltage. The asymmetric nano-porous nickel and graphene-copper supercapacitor yielded over 8X more capacitance over the symmetric nano-porous nickel. In addition, when compared against a conventional activated-carbon (1-2 µm thick) supercapacitor, the asymmetrical nano-porous nickel and graphene-copper supercapacitor had 53X more capacitance.

Awards Won:

Fourth Award of $500

Drexel University: Full tuition scholarship $194,000