



Vertically oriented graphene electric double layer capacitors

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Abstract

The development of electrical double layer capacitors using vertically oriented graphene nanosheets with fast frequency response continues. The inherent open morphology of the nanosheet films is such that it allows efficient ingress and egress of electrolyte ions, making them suitable for AC line filtering. Since the molecular surface area is only about a factor of $\sim 320\times$ over the geometric area, the specific capacitance available remains limited. This dissertation presents a study of the growth of vertically oriented graphene nanosheets on Ni and Al substrates and the resulting performance as electrical double layer capacitors. Additionally, the underlying architecture of VOGN on Ni is used for coating with high surface area carbon black to substantially increase the specific capacitance while still retaining the open morphology to allow good frequency response at 120 Hz. The carbon black coating was deposited on ~ 1.2 mm high vertically oriented graphene nanosheets providing a specific capacitance of 2.3 mF/cm^2 at 120 Hz. This is the highest specific capacitance at 120 Hz for electric double layer capacitors reported to date and is now in the range to replace some electrolytic capacitors.