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Graphene-based Electrochemical Capacitors

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Electrochemical capacitors, oftentimes called supercapacitors, are energy storage devices like batteries, yet they can be recharged a hundred to a thousand times faster. Because of their enabling features, supercapacitors have been replacing batteries and capacitors in an increasing number of applications. Their high power density and excellent low temperature performance have made them the technology of choice for cold starting, backup power, flash cameras and regenerative braking. They also play an important role in the progress of hybrid and electric vehicles. However, the low energy density of current carbon-based supercapacitors is the main impediment to realizing the full commercial potential of this technology. This has triggered tremendous research efforts in order to develop new electrode materials that are capable of providing a large amount of energy in a short period of time. Here we explore the current status of graphene-based supercapacitors, highlight ongoing research activities and present challenges that must be addressed. Several examples will be given on the rational design and fabrication of electrodes with the goal of making compact, reliable and energy dense supercapacitors that are mechanically flexible and possess both long cycle life and calendar life. For example, hybrid electrodes that use battery type materials such as manganese dioxide can be incorporated into graphene to significantly increase the energy density.

Keywords: supercapacitors, graphene, energy density, power density