Replacing Lithium-ion Batteries with Graphene Based Supercapacitors

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This project demonstrates that a new paradigm in energy storage should be considered. Materials science engineers have historically focused on creating ever more energy dense materials to get around the large charge cycles of lithium-ion batteries, which serves only to increase manufacturers profit margins, while disregarding the economic, material scarcity, environmental, and safety concerns that should be paramount factors in design considerations. This engineering project examines replacing lithium-ion cells (LI) and electronic components with graphene supercapacitors and analogous electronic components. These were tested for their self discharge rates, charge cycles, and power output compared to new LI batteries. The results show that supercapacitors of comparable size and cost, output higher levels of power with only slightly lower energy density (~75% of LI when new and 88% after six months). This lower energy density is overshadowed by faster charge times (~⅓ that of LI at 15A), and the nearly limitless charge cycles that they possess (millions of cycles vs. thousands). What's more, these charge times reflect rates achieved with a relatively low amperage and can be significantly decreased owing to the fact that supercapacitors have an extremely low equivalent series resistance which gives them high current tolerance. Standard household 120V systems can charge graphene based supercapacitors, even those with greater amperage output, in minutes to full charge making supercapacitors a superior alternative to traditional LI battery packs.