Graphene-enhanced electrodes for scalable supercapacitors

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Activated carbon, as I have already read about extensively, is what is most widely used as the electrode material in supercapacitors. This paper presents data on electrodes made of graphene and graphene AC (activated carbon) hybrids. A drawback to most activated carbons is that they have a low electric conductivity. The electrochemically exfoliated graphene (EEG) and EEG/AC (Hybrid) electrodes used in experimentation in this paper had an electrical conductivity of 2.68E4 S/m. Carbon nanotubes are an alternative to AC as well because of their high electrical conductivity, however the structure of them severely decreases the specific capacitance of the SC. Thus, EEG and EEG/AC electrodes have been a prominent area of study in the SC realm because of their high capacitance, extremely porous structure, and high thermal and chemical stability.

The authors begin their experimental method with a very lengthy account on how their graphene was produced in the lab. At first the authors created these SC on a very small scale, and then scaled them up to see what properties would change. What was found after putting each type of SC through upwards of 60,000 cycles was that scaling up did close to nothing to effect the electrochemical properties of the electrodes. EEG/AC hybrids increased the specific capacitance of AC electrodes alone quite significantly, but complete EEG electrodes reached the highest power density of all electrodes tested, 65 kW/kg using a 6 molar potassium hydroxide dielectric. The highest specific power that an AC/EEG electrode produced was 20 kW/kg (for the 1:1 mass ratio).

AC/EEG electrodes offer a cost-effective and power-effective way to increase the capacitance capabilities of AC electrodes. There is only a small adjustment to AC electrodes needed in order to unlock the full potential of the hybrid. To mix these two, all that was done was to add different weight ratios of AC and EEG powder for super-pure water for 24 hours. The best ratio for mixing, as in the ration that increased the specific capacitance the most was a 50/50 weight ratio of AC to EEG powder. After 10,000 cycles of the scaled up version, the capacitance of the SC was retained to above 95% of the original.

Graphene and graphene/AC hybrid electrodes seem like a very good way to produce electrodes. The authors here not only tried to test the performance of these electrodes but also tried to prove that these systems could be scaled up to a commercial level. The drawbacks of these types of electrodes were not really stated, and it would be helpful to read a paper against the use of these electrodes. It may be that this really is the way to go but it needs to pick up steam in the industry first.