Towards Cheaper Energy Storage Devices – What is Possible with Inexpensive of the Shelf Materials in Supercapacitors

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Abstract

Supercapacitors have gained considerable attention, because of their unique combination of a high power density and outstanding cyclability. While there is a steady growth in the supercapacitor market, widespread application is inhibited by the high cost per unit of energy stored. This study focuses on the identification of cheap alternatives to the common organic electrolyte supercapacitor technology by identification of attractive aqueous electrolyte and activated carbon combinations. Typically, specialized carbons are employed, which combine high surface area with low surface functionalization, to combine high energy density with good stability also at high potential windows. Nevertheless, these specialized carbons come with a hefty price tag, especially if combined with expensive organic electrolytes. While aqueous electrolytes are limited in the electrochemical window, recent results show, that the window can be expanded for highly concentrated solutions [1], they are a factor 100-1000 cheaper and can have due to the lower potentials less requirements for the carbon material. This study demonstrates the potential of combining cheap electrolytes and common commercial activated carbon for supercap applications, where price and not the performance is actually the limiting factor. In a first step for a variety of 13 highly concentrated aqueous electrolytes the electrochemical window was identified and evaluated, three were chosen as the most promising candidates. Subsequently commercial activated carbons, usually employed in flue gas or water purification, are tested as electrode material with these promising candidates. E.g. for the combination of 1 M Na_2SO_4 with Silcarbon CW 20 a capacitance of 91 F g^{-1} and a voltage window of 1,8 V can be achieved.

[1] H. Tomiyasu, H. Shikata, K. Takao, N. Asanuma, S. Taruta, Y.-Y. Park, *Scientific Reports* **2017**, *7*, 45048.