

# Redox organic materials for low cost sodium aqueous batteries and non-aqueous supercapacitors

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The increasing importance of renewable energy sources like sunlight and wind power connected to the electrical grid has triggered the necessity of low cost energy storage systems. In this context, redox organic materials constitute a promising source of active compounds. In this work, the interest of these organic materials is demonstrated through two approaches: one involving the development of low cost sodium aqueous batteries, the other one being devoted to that of pseudocapacitive supercapacitors based on grafted carbon electrodes.

Sodium aqueous electrolyte ion-batteries constitute a new promising technology, which reduces the cost, risk and environmental impact compared to other battery technologies. Today, the performances of these batteries are limited however, by low capacity negative and positive electrodes that are in addition associated with significant side reactions with the aqueous electrolyte. To address these issues, the electrochemical and physical behavior of n and p type derivatives have been investigated in various aqueous supporting electrolytes. Results allow to identify the key factors governing the long term stability on cycling. Capacity as high as 90 mAh/g for more than 200 cycles with a coulombic efficiency very close to 100% can be obtained even at slow rate.

We also report a facile method for grafting of 1-nitropyrene (Pyr-NO<sub>2</sub>) onto highly graphitized carbon onion as electrodes for supercapacitors. This is achieved through lowering of the onset potential of the pyrene unit polymerization via in-situ reduction of the NO<sub>2</sub> group. The additional redox activity associated with the NO<sub>2</sub> redox activity allows to surpass the faradic capacity solely associated with the p-doping of the grafted pyrene backbone, as it is observed for the pyrene, 1-aminopyrene, and unreduced Pyr-NO<sub>2</sub>. Upon 20 wt % grafting of Pyr-NO<sub>2</sub> the capacity of the electrode jumps from 20 mAh/g electrode to 38 mAh/g electrode which corresponds to 110 mAh/gPyr-NO<sub>2</sub> per mass of Pyr-NO<sub>2</sub>. Altogether, this results in a striking increase of the energy density vs. the Li counter electrode by 90 % (29 to 55 Wh/Kg electrode), while the average potential is increased by 18 %. Very interestingly, such high performance comes together with outstanding retentions of both the initial capacity for more than 4000 cycles and power characteristics demonstrating the superior advantages of the present in-situ grafting technique. Lastly and most importantly, a full cell is demonstrated by combining Li-terephthalate/carbon as anode.