Zn-ion hybrid supercapacitors based on solutions of different electrolytes

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The development of high efficiency energy storage systems is increasingly important as these systems enable utilize energy from renewable sources and reduce greenhouse gas evolution caused by fuel combustion technologies at the same time. This work provides some insight into the strategy for designing effective non-aqueous and aqueous Zn-ion hybrid supercapacitors.

Electrochemical characteristics of Zn-ion hybrid supercapacitor (ZIHS) cells based on 1 M acetonitrile (AN) and propylene carbonate (PC) electrolytes in $Zn(BF_4)_2$, zinc di[bis(trifluoromethylsulfonyl)imide] ($Zn(TFSI)_2$) and zinc trifluoromethanesulfonate ($Zn(OTf)_2$) have been studied. Very high energy and power densities (80 Wh kg^{-1} and 21.2 kW kg^{-1}) have been calculated for 1 M $Zn(BF_4)_2$/AN based Zn-ion based hybrid supercapacitors (Fig. 1a). Very good stability after 3000 cycles of cells has been achieved demonstrating reasonably high energy efficiency value (66.8%) for $Zn(TFSI)_2$/AN based ZIHS cell, and decreased in the order electrolytes: $Zn(TFSI)_2$/AN > $Zn(BF_4)_2$/PC > $Zn(TFSI)_2$/PC > $Zn(OTf)_2$/AN > $Zn(BF_4)_2$/AN. Some assembled ZIHSs had shown excellent cycling and energy stability over 20000 cycles.[1]

Electrochemical behaviour of Zn cation based salt in various aqueous electrolytes ($ZnSO_4$, $Zn(BF_4)_2$, $Zn(TFSI)_2$, and $Zn(OTf)_2$) has been studied in thin Zn foil|carbon cloth hybrid supercapacitor cell and compared with $Zn(ClO_4)_2$ aqueous electrolyte based cell electrochemical characteristics. At moderate specific power value (10 kW kg^{-1}) noticeable decrease of specific energy has been established in the order of aqueous based electrolytes: $Zn(ClO_4)_2 \geqslant Zn(BF_4)_2 > Zn(OTf)_2 > Zn(TFSI)_2 > ZnSO_4$ (Fig. 1b). The stability of Zn-ion hybrid supercapacitor cells under study in aqueous electrolyte solutions has been tested using the long lasting (up to 10000 cycles) constant current charge/discharge method and very good stability for $Zn(OTf)_2$, $Zn(ClO_4)_2$ and $ZnSO_4$ has been observed.[2,3]

Taking into account the very cheap and environmental friendly electrodes and electrolyte used, the results can be applied for completing of the cheap high energy density hybrid supercapacitors for sustainable energy storage/recuperation complexes, combined with photovoltaic fields and/or wind electricity generating systems.

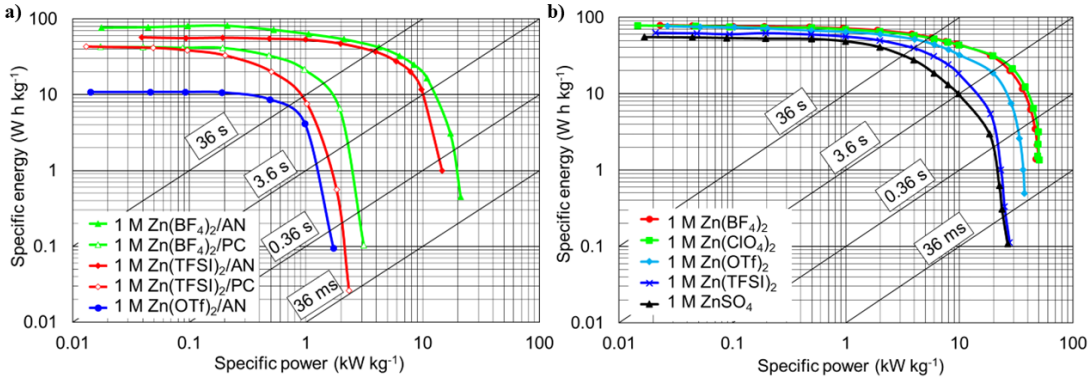

Figure 1. Ragone plots (gravimetric data) for different non-aqueous ZIHSs measured within voltage range from 2.0 to 0.5 V (a), and for different aqueous ZIHCs measured within voltage range from 1.8 to 0.4 V (b).

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