Improving the energy density of Zn-ion capacitors with bio-ionic liquid electrolytes containing redox species

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Zinc-ion capacitors (ZICs) are gaining a lot of interest due to their safety, recyclability, high theoretical capacity (820 mAh g^{-1}), and reasonable energy and power density. The cathode and electrolyte play an important role in order to improve the energy density of the capacitor. Aqueous electrolytes have been studied in detail for use in ZICs which have shown issues related to Zn dendrite formation, hydrogen evolution reaction, cathode dissolution and limited stability[1, 2].

Here we have studied sustainable bio-ionic liquids electrolytes in ZICs with Zn anode and graphene cathode. We observed that compared to aqueous Zn acetate electrolytes, the addition of bio-ionic liquid (i.e., Choline acetate) improves the capacitance from 130 F g^{-1} to 160 F g^{-1} at a current density of 0.5 A g^{-1}. Furthermore, the addition of redox species in the electrolyte leads to a redox reaction within the electrochemical window, thereby increasing the capacity to 260 F g^{-1}. Raman and XPS studies showed that the presence of redox species leads to a possible strain induced interaction/deintercalation process which might be responsible for improved capacitance. Density functional theory (DFT) based quantum chemical calculations were performed to understanding the influence of the redox species on the geometrical and local electronic properties of the interface between the bio-ionic liquids and graphene. Based on our studies, we conclude that bio-ionic liquids are promising novel and sustainable electrolytes for Zn-ion capacitors.

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References

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