5th European Symposium on Supercapacitors & Hybrid Solutions
April 23-25, 2015

High energy AC/AC electrochemical capacitors based on aqueous mixture of salt and redox active electrolyte

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Abstract

Activated carbon (AC) based symmetric capacitors in organic ($TEABF_4$ in acetonitrile) and aqueous (KOH and H_2SO_4) electrolytes are commercially used. However, due to the environmental unfriendly character of the former and low operating cell potential of the later, alternative electrolytes are desirable. Recently, salt aqueous electrolyte e.g., 1 mol L^{-1} Li_2SO_4 (pH = 6.5) based capacitors capable of operating up to ~2 V have been reported. Such high cell potential is realized owing to the high over-potential for di-hydrogen evolution at the negative AC electrode [1]. However, potentiostatic floating tests revealed that capacitors constituted of stainless steel current collectors can operate only up to 1.5 V [2]. Besides, it was reported that iodide (I^-) based aqueous AC/AC capacitors exhibit high capacitance (C) due to the I^-/I_2 redox couple, however, with cell potential (U) only up to 1.2 V [3].
In this work, an aqueous mixture of manganese sulfate (2 mol L^{-1} $MnSO_4$) and potassium iodide (0.5 mol L^{-1} KI) with pH = 3 has been used in order to take simultaneously advantage of the I^-/I_2 redox couple and high cell potential allowed by $MnSO_4$. Two-electrode cell experiments demonstrate that $MnSO_4$ based capacitors are able to operate up to 1.4 V under potentiostatic floating for 120 h. The addition of KI – 0.5 mol L^{-1} - to 2 mol L^{-1} $MnSO_4$ results in enhanced capacitance of 372 F g^{-1} (calculated from galvanostatic charge/discharge curves at 0.2 A g^{-1}) up to cell potential of 1.5 V compared to 161 F g^{-1} up to cell potential of 1.4 V for $MnSO_4$ (2 mol L^{-1}) (Fig. 1a). Interestingly, the presence of iodide improves the cyclability under potentiostatic floating at 1.5 V for 120 hours, where the capacitor exhibits constant capacitance of ~220 F g^{-1} and low cell resistance of 2 ohm (Fig. 1b). Experiments in two-electrode cells with a reference electrode show that, at pH = 3, the I^-/I_2 redox couple displays a high activity with a small potential window at the positive AC electrode, while the negative AC electrode mainly exhibits an EDL behavior, determining the overall capacitive performance of the system.

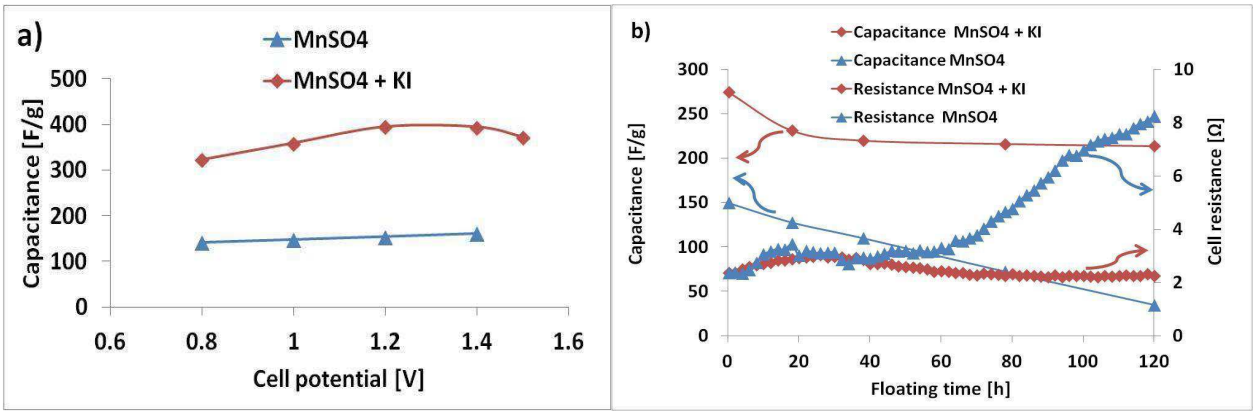

Figure 1: *(a) Capacitance (determined at 0.2 A g^{-1}) vs. cell potential; (b) capacitance and cell resistance during floating at 1.5 V of AC/AC capacitors based on $MnSO_4$ (2 mol L^{-1}) and $MnSO_4$ (2 mol L^{-1}) + KI (0.5 mol L^{-1}).*

REFERENCES

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