Electronic Supplementary Material (ESI) for Energy & Environmental Science

A novel insight into neutral medium as electrolyte for high-voltage supercapacitors

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SUPPORTING INFORMATION

1. Cyclability of capacitor operating in Li_2SO_4, Na_2SO_4 and K_2SO_4 (1 mol L^{-1}) solutions

To compare the stability of capacitors operating in different alkali metal sulphate solutions as electrolytes, cyclability tests were performed. Capacitor was charged/discharged during 5 000 cycles at the current density 1 A g^{-1}. The capacitance vs. cycle number dependence for these capacitors is placed below.

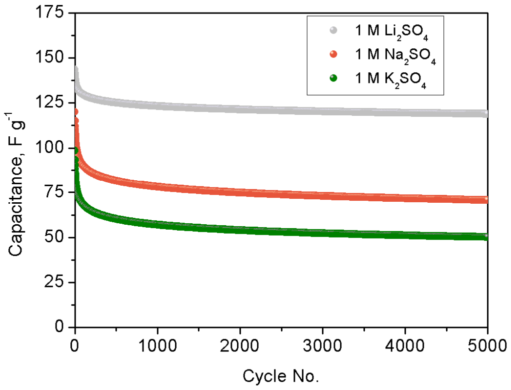

Fig. 1 Cyclability of capacitor operating in Li_2SO_4, Na_2SO_4 and K_2SO_4 (1 mol L^{-1}) solutions

Capacitor operating in lithium sulphate solution as electrolyte was characterized by stable capacitance values (ca. 120 F g^{-1}) during 5 000 cycles, whereas for sodium sulphate solutions it was about 75 F g^{-1} and for K_2SO_4 the capacitance was equal to ca. 50 F g^{-1}.

2. Solubility of Li_2SO_4 in water

Lithium sulphate reveals reversed solubility in water with temperature increase. However, it might aggravate capacitor behavior at higher temperatures, because the local concentration in pores can be higher than in electrolyte bulk and Li_2SO_4 can precipitate resulting in resistance increase. As it can be seen from the Fig. 2 the solution of 1 mol L^{-1} is in the safe non-crystallization region, below meta-stable phase. Hence, the best electrochemical behavior can be observed for 1 mol L^{-1} Li_2SO_4 solution as electrolyte.

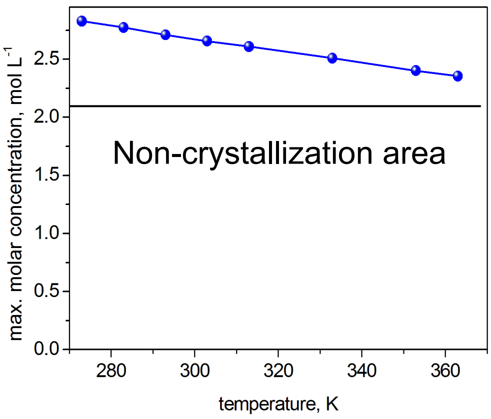

Fig. 2. Solubility of Li_2SO_4 in water vs temperature dependence

3. Electrochemical impedance spectroscopy at different voltages

Electrochemical impedance spectroscopy was also performed for capacitor operating at 0.8, 1.6, 2.2 V and reveal small increase of resistance, which might suggest a slight oxidation of the electrodes. However, after cycling at 2.2 V no significant increase of resistance was observed.

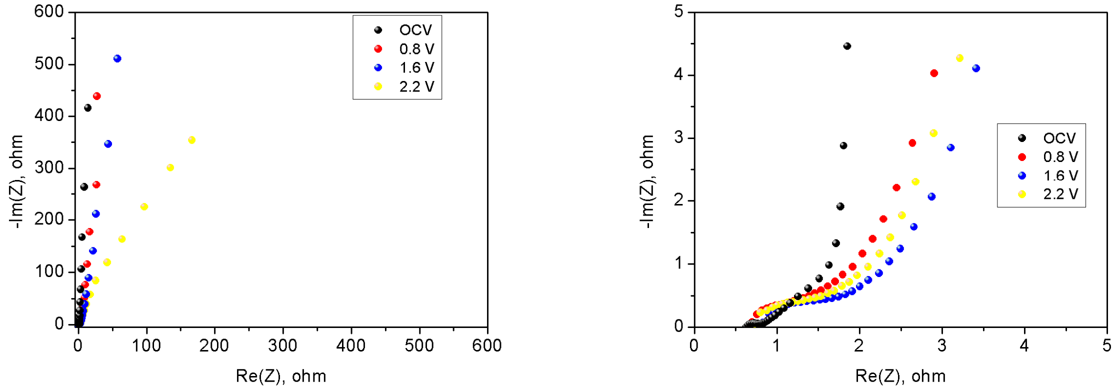

Fig. 3. Nyquist plots recorded at different capacitor voltage for 1 mol L^{-1} Li_2SO_4 as electrolyte

4. Electrochemical impedance spectroscopy before and after cycling

Impedance spectra recorded before and after cycling (5 000 cycles) of capacitor operating at 2.2 V with 1 mol L^{-1} Li_2SO_4 aqueous solution are placed below.

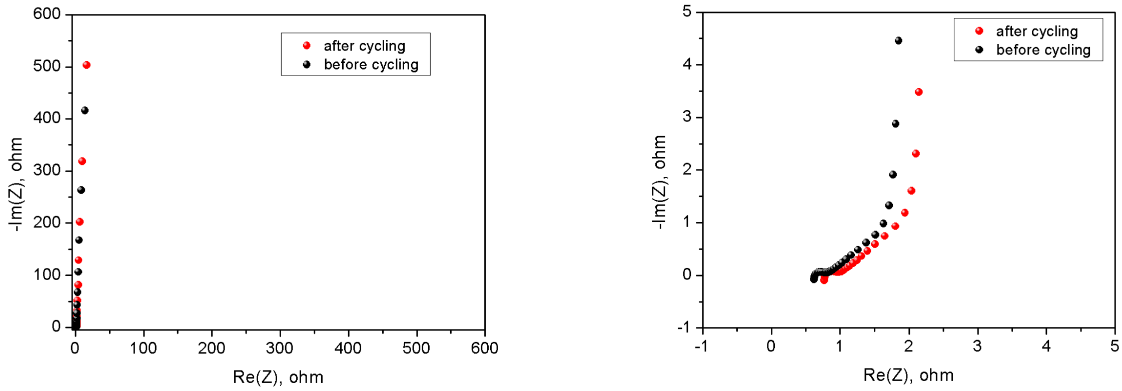

Fig. 4. Nyquist plots recorded before and after cycling for 1 mol L^{-1} Li_2SO_4 as electrolyte

As it can be observed, no significant increase of the resistance was observed which proves that there is no electrolyte decomposition during cycling.