Electronic Supplementary Material (ESI) for Physical Chemistry Chemical Physics

Supporting information

of

An advanced, highly efficient sodium-ion rechargeable battery

by

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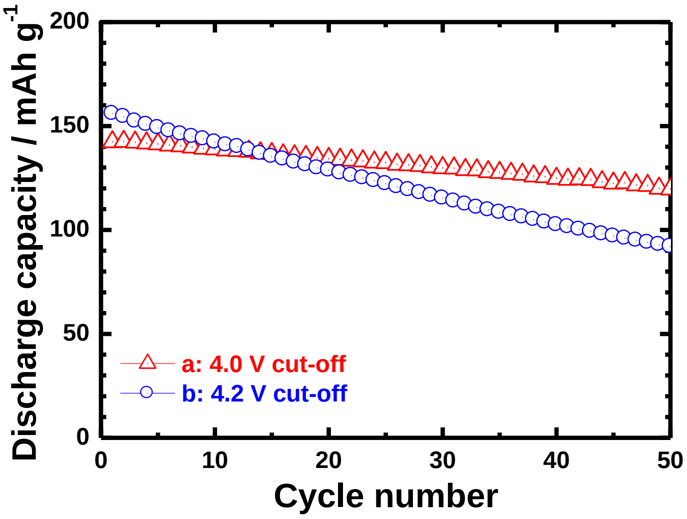

Figure S-1. Discharge capacity versus cycle number within 2.2 V-4.0 V and 2.2 V-4.2 V, respectively, voltage limits of the Na/ $Na(Ni_{0.5}Mn_{0.5})O_2$ cell at room temperature (Current density: 12 mA g^{-1}, electrolyte: 1.0M $NaClO_4$ in PC with 2 vol% FEC).

Figure S-1 exhibits continuous capacity delivery versus cycle numbers at two cut-off voltage limits of the Na/ $Na(Ni_{0.5}Mn_{0.5})O_2$ cell. At 4.0 V voltage limit the capacity retention is about 93 % of the initial value. At 4.2 V voltage limit the deliver capacity is higher but the retention is much lower, i.e., passing from 155 mAh g^{-1} to about 90 mAh g^{-1} over the cycling test.

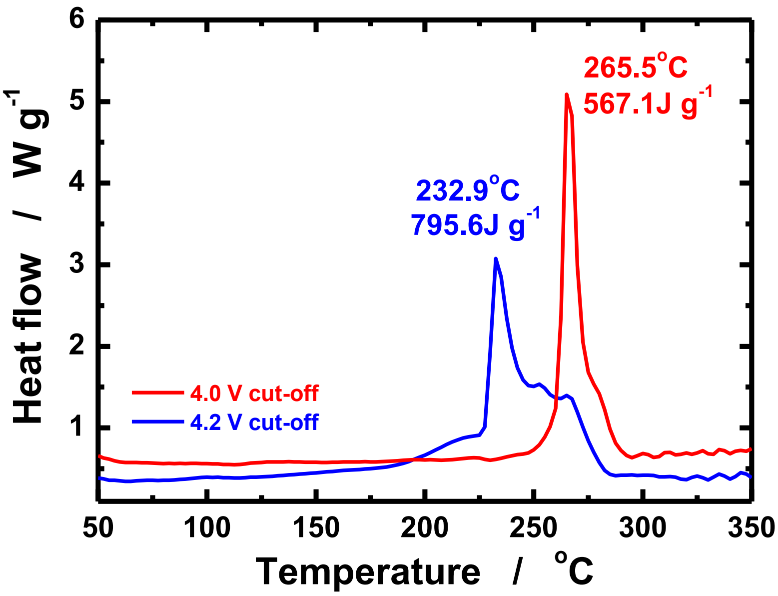

Figure S-2. Differential scanning calorimetry traces showing heat flow from the reaction of the electrolyte with a fully charged cell Na/ $Na(Ni_{0.5}Mn_{0.5})O_2$ cell at two different cut-off voltages (2.2 V-4.0 V and 2.2 V-4.2 V).

Figure S2 shows differential scanning calorimeter (DSC) profiles of two $Na_{\delta}(Ni_{0.5}Mn_{0.5})O_2$ electrodes, one fully charged to 4.0 V ($Na_{0.375}Ni_{0.5}Mn_{0.5}O_2$) and the other at 4.2 V ($Na_{0.021}Ni_{0.5}Mn_{0.5}O_2$), both wetted with the $NaClO_4$ PC-FEC electrolyte. For the former, the onset temperature for the exothermic reaction is around 250 ^{o}C while the main reaction occurs at 265 ^{o}C along with a total associated heat of 567.1 J g^{-1}. As expected, the reaction shifts to the lower temperature of about 234 ^{o}C for the electrode fully charged to 4.2 V and the total associated heat increases to 795.6 J g^{-1}. Considering the high oxidation state of Ni, which is close to +4, the relatively low heat generation of 795.6 J g^{-1} is notable and better than that associated with the general class of delithiated transition metal oxides.