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Towards high energy density, low cost and safe Na-ion full-cell using P2−$Na_{0.67}[Fe_{0.5}Mn_{0.5}]O_2$ and $Na_2C_4O_4$ sacrificial salt

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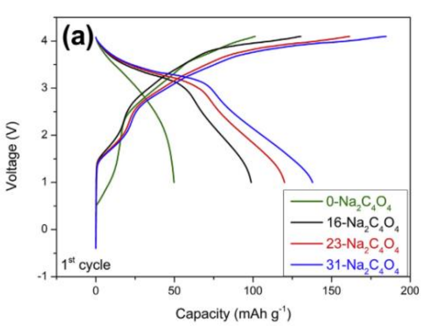
A B S T R A C T

The sodium deficiency issue of $Na_{0.67}[Fe_{0.5}Mn_{0.5}]O_2$, P2-type layered oxide, is compensated with the addition of $Na_2C_4O_4$ as sacrificial salt. $Na_2C_4O_4$ is easy to synthesize and stable, which makes it easy to handle and scale-up. Sodium-free hard carbon anode and sodium-deficient layered oxide cathode, mixed with different amounts of $Na_2C_4O_4$, are used to assemble Na-ion full-cells and evaluate the effect of the sacrificial salt content in the electrochemical performance of the cells. *Ex-situ* SEM and XRD analyses confirmed that the Na^+ ions formed as a result of the electrochemical decomposition of the salt, are reinserted back into the cathode structure. Thus, $Na_{0.67}[Fe_{0.5}Mn_{0.5}]O_2$ undergoes same phase transitions when tested as full-cell using Na-free hard carbon or with a Na° anode that compensates for the Na deficiency. In comparison with NaN_3 sacrificial salt, $Na_2C_4O_4$ seems to be a better candidate as sodiation agent in terms of safety and handling. The electrochemical performance of the P2-type layered oxide with 31% of $Na_2C_4O_4$ sacrificial salt outperforms the cathode with NaN_3 with improved cycling stability, delivering a reversible capacity of 155 mAh g^{-1} and an energy density of 165 Wh kg^{-1}.



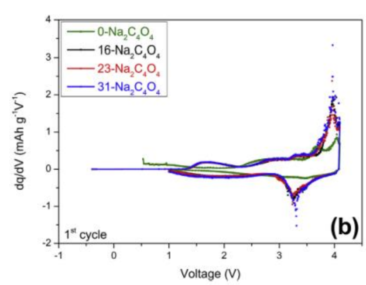


Fig. 2. (a) 1st galvanostatic cycling profiles and (b) differential capacity curves of 0-$Na_2C_4O_4$, 16-$Na_2C_4O_4$, 23-$Na_2C_4O_4$ and 31-$Na_2C_4O_4$ full-cells (1–4.1 V).

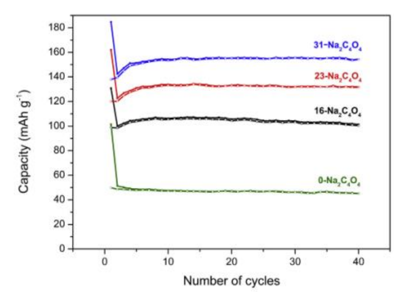


Fig. 3. Cycling performance of 0-$Na_2C_4O_4$, 16-$Na_2C_4O_4$, 23-$Na_2C_4O_4$ and 31-$Na_2C_4O_4$.

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