An Ultrafast Lithium-ion Battery with Long-term Cycling Performance Based on Hard Carbon

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In this work, we construct lithium-ion batteries (LIBs) with capacitive-level cycling performance and ultrafast charge/discharge via electrode engineering. Two typical battery-type materials are used, namely, $\text{LiNi}_{0.6}\text{Co}_{0.2}\text{Mn}_{0.2}$ as the cathode material and hard carbon (HC) without pre-lithiation as the anode material. In addition to the reasonable electrode design, it is concluded after analysing the energy storage mechanism that the capacitive-controlled storage behaviour of HC materials in a full cell configuration is the major reason that the device exhibits superior cycling performance. By conducting a galvanostatic charge/discharge cycling test of a 144 mAh battery at 10C ($t_{\text{charge}}/t_{\text{discharge}} \approx 4.8$ min), the capacity retention rate of the battery is 99.36% after 32000 cycles. The specific energy reaches $43.59 \text{ Wh} \cdot \text{kg}^{-1}$ at $42.01 \text{ W} \cdot \text{kg}^{-1}$ within a discharge time of 67.3 s, while the energy density is $29.55 \text{ Wh} \cdot \text{kg}^{-1}$ at $1580.81 \text{ W} \cdot \text{kg}^{-1}$; these values are calculated based on the weight of the whole device. This work expands the application range of HC materials in the field of batteries.

Keywords: lithium-ion battery, hard carbon, cycle life, $\text{LiNi}_{0.6}\text{Co}_{0.2}\text{Mn}_{0.2}$, ultra-fast charge/discharge

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