Performances of $LiFePO_4$/graphite Lithium-ion Batteries with Different Capacity Ratios of Negative to Positive Electrode

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The rate and cycle performances of $LiFePO_4$/graphite lithium-ion batteries with different capacity ratios of negative to positive electrode (N/P ratio) were explored by using 2032 coin-type full cells. $LiFePO_4$/graphite coin cells were assembled with the N/P ratios of 0.87, 1.03 and 1.20, which were adjusted by varying the thickness of graphite negative electrode. Cycle performances of the cells were evaluated by repeating the charge-discharge 5000 times (1 C-rate for 1st-1000th cycle, 2 C-rate for 1001th-5000th cycle) at the cell voltage of 2.5-4.2 V, during which their rate performances were intermittently evaluated (0.1-10 C rate). Prior to the charge-discharge cycling test, the highest cell specific capacity was obtained from the lowest N/P ratio of 0.87. Discharge cell specific capacities of the cells during the cycling test are shown in Figure 1. The cell with the highest N/P ratio of 1.20 exhibited the highest capacity retention of 86.5 % in the 5000-cycles tests. Higher N/P ratio was beneficial to mitigate the capacity fading of cells caused by the cycling. The lower N/P ratio led to the deeper Li-ion intercalation for the graphite negative electrode, which reduced the potential of both the positive and negative electrodes. The lower N/P ratio was beneficial to bring out the full performances from their initial service, but allowed larger capacity fading due to the aging by cycling. The higher N/P ratio rather saved the performances at the initial service, which was useful to prevent the capacity fading. The lowering of rate performance owing to the charge-discharge cycling was enhanced by the decrease in the N/P ratio.

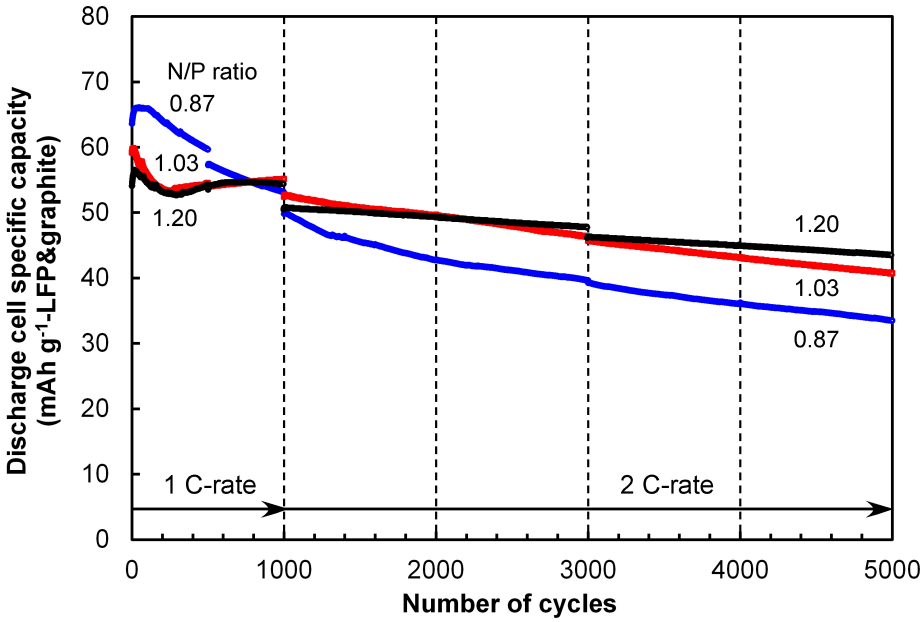

Figure 1. Discharge cell specific capacity of the LFP/graphite coin cells during the cycle test. 1 C-rate and 2 C-rate indicate charge/discharge current density of 170 and 340 mA g^{-1}-LFP, respectively. Cut-off cell voltage range was 2.5-4.2 V.