Electronic Supplementary Material

Performance optimization of freestanding MWCNT-$LiFePO_4$ sheets as cathodes for improved specific capacity of lithium-ion batteries

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Mass loading of freestanding MWCNT-$LiFePO_4$ sheets at different gap size:

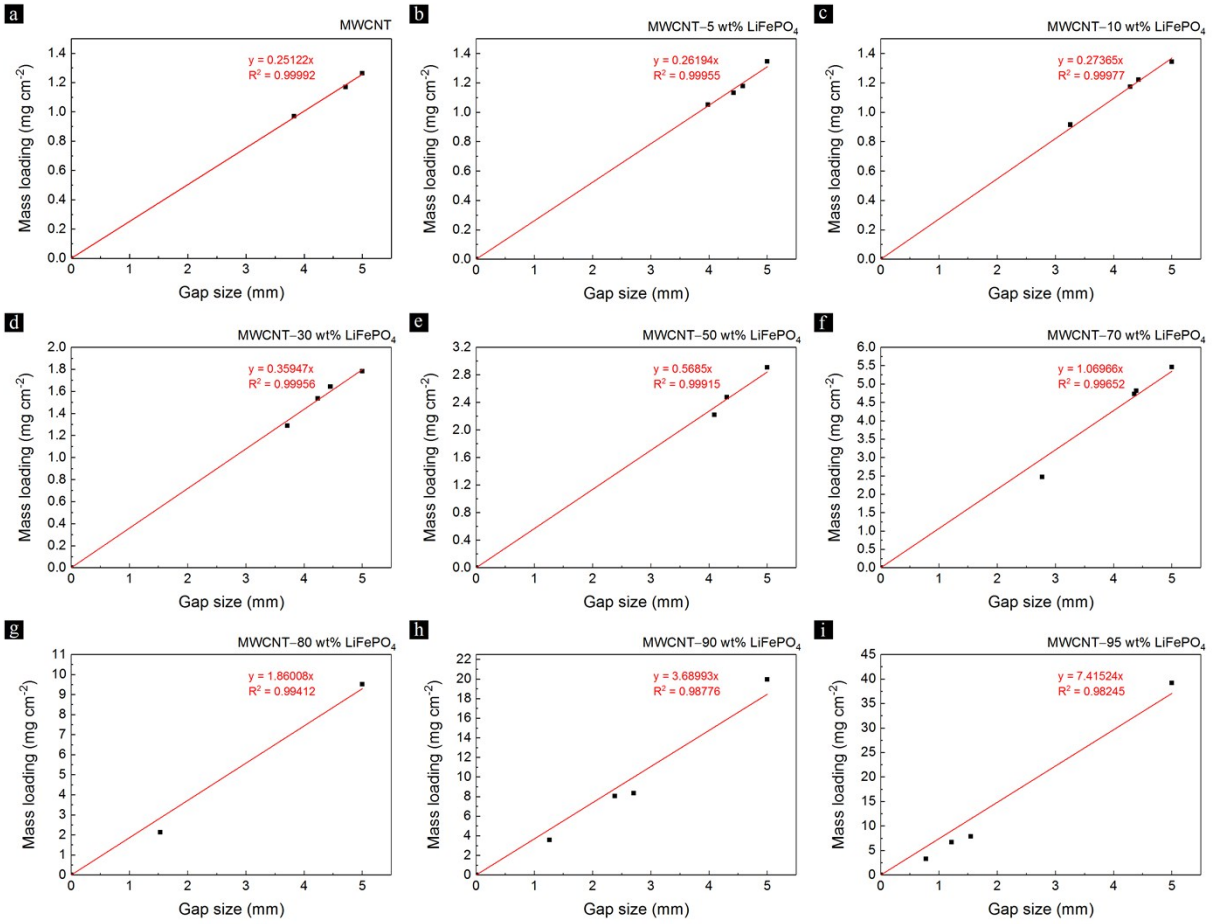

Figure S1 The resulting mass loading at different gap size of the film applicator of (a) pristine MWCNT and (b-i) MWCNT-$LiFePO_4$ with (b) 5 wt% $LiFePO_4$, (c) 10 wt% $LiFePO_4$, (d) 30 wt% $LiFePO_4$, (e) 50 wt% $LiFePO_4$, (f) 70 wt% $LiFePO_4$, (g) 80 wt% $LiFePO_4$, (h) 90 wt% $LiFePO_4$, and (i) 95 wt% $LiFePO_4$.

Ball-milling treatment:

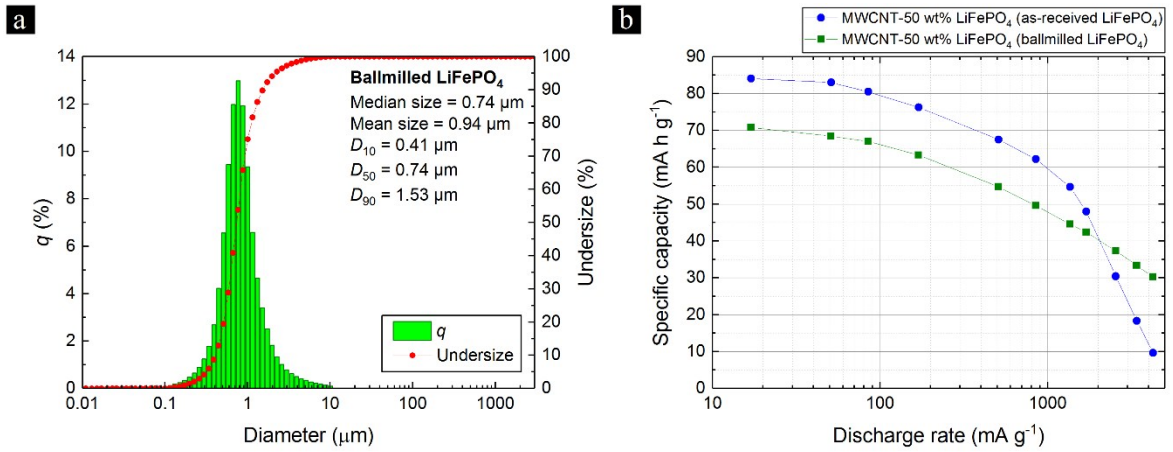

Figure S2 (a) The particle size distribution of ballmilled $LiFePO_4$. (b) The specific capacity at different discharge rate of MWCNT-50 wt% $LiFePO_4$ from as-received $LiFePO_4$ and ballmilled $LiFePO_4$ powders.

We produced ballmilled $LiFePO_4$ powders using ballmill machine. The ballmilled $LiFePO_4$ powders have a smaller median size of 0.74 µm (Figure S2a) compared to 3.55 µm of as-received $LiFePO_4$ powders. Figure S2b shows the effect of particle size to specific capacity of MWCNT-$LiFePO_4$ at a fixed $LiFePO_4$/MWCNT ratio of 1. The MWCNT-50 wt% $LiFePO_4$ from ballmilled $LiFePO_4$ powders shows superior specific capacity of 37.3, 33.4, 30.2 mA h g^{-1} compared to 30.4, 18.3, 9.6 mA h g^{-1} of sample using as-received $LiFePO_4$ powders, at high discharge rate of 2550, 3400, 4250 mA g^{-1}, respectively. This is attributed to small lithium-ion diffusion distance in $LiFePO_4$ particle. The MWCNT-50 wt% $LiFePO_4$ from ballmilled $LiFePO_4$ powders shows smaller specific capacity of 70.8 instead of 84 mA h g^{-1} at low discharge rate of 17 mA g^{-1}. It might be due to oxidation of the high surface-to-volume-ratio particles during ballmill (non-optimized ballmilling process), which leads to a decrease in the amount of Li^+ ions which can be exchanged and cycled. Nevertheless, we showed that the reduction in particle size leads to better performance at high discharge rate.