Enhanced cycling performance of nanostructure LiFePO$_4$/C composites with in-situ 3D conductive networks for high power Li-ion batteries

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The SEM and TEM images of LFP-S and LFP/C-S were measure in Fig.S1

![Fig.S1. SEM images for (a) LFP-S and (b) LFP/C-S, TEM images for (c, d) LFP/C-S](image_url)

The Li$^+$ diffusion coefficient at open circuit state could be calculated from the slanted lines in the Warburg region by Eq. 1: [1]

$$D_{Li} = \frac{R^2 T^2}{2A \hat{R} \hat{F}} C_0^2 \sigma^2$$

(1)

where $D_{Li}$ is the diffusion coefficient in LiFePO$_4$ (cm$^2$ s$^{-1}$), $R$ is the gas constant (8.31 J mol$^{-1}$ K$^{-1}$), $T$ is the absolute temperature (298 K), $A$ is the surface area of active material, $n$ is the number of electrons transferred per molecule during the electrochemical reaction, $F$ is the Faraday constant (96485 C mol$^{-1}$), $C_0$ is the molar concentration of lithium ion in LiFePO$_4$ ($1.1 \times 10^{-2}$ mol cm$^{-3}$ here), and $\sigma$ is the Warburg factor associated with $Z_{re}$ by Equation 2: [1]

$$Z_{re} = K + \sigma \omega^{-1/2}$$

(2)

The Warburg factor can be obtained from the slope between $Z_{re}$ and the $\omega^{-1/2}$ where $D_{Li}$ is the Li$^+$ diffusion coefficient in LFP (cm$^2$ s$^{-1}$), $\sigma$ is the Warburg factor associated with $Z_{re}$ ($Z_{re} \propto \sigma \omega^{-1/2}$). After linear fitting the relation plot between $Z_{re}$ and the reciprocal square root of the angular frequency $\omega$, as shown in Figure S2, the $\sigma$ of LFP/C-F and LFP/C-S were calculated to be 14.276 and 24.01 Ω·s$^{-1/2}$, respectively.
Fig. S2. the relationship between $Z_{re}$ and the $\omega^{-1/2}$ of LiFePO$_4$/C composites

Reference