Supporting Information

The effect of magnetic field on the rate performance of $Fe_2O_3/LiFePO_4$ composite cathode for Li-ion batteries

Emmanuel Iheonu Nduka[1&], Nazgul Assan[1&], Mukagali Yegamkulov[2], Aliya Mukanova [1,2], Zhumabay Bakenov[1,2,3*]

[1] *Department of Chemical and Materials Engineering, School of Engineering and Digital Sciences, Nazarbayev University, Astana 010000, Kazakhstan*

[2] *National Laboratory Astana, Nazarbayev University, Astana 010000, Kazakhstan*

[3] *Institute of Batteries LLC, Nazarbayev University, Astana 010000, Kazakhstan*

&E.I.N., N.A. – these authors contributed equally

*Corresponding Author: zbakenov@nu.edu.kz

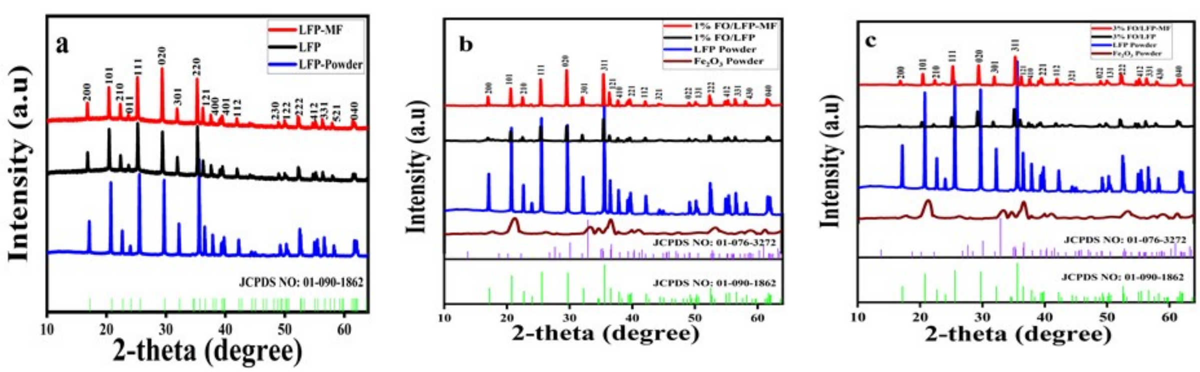

Fig. S1. XRD patterns of cathodes: (**a**) LFP and LFP-MF; (**b**) 1%FO/LFP and 1%FO/LFP-MF; and (**c**) 3%FO/LFP and 3%FO/LFP-MF

Diffusion coefficient of Li ions (D) in the electrode:

Fig. S2 depicts the associations between peak currents and the square root of scan rate for LFP-MF and LFP-WMF. The Randles-Sevcik equation was used to calculate the diffusion coefficient of Li ions (D) for an electrode:

$$I_p = 2.59 \times 10^5 \times A \times C \times D_{Li+}^{0.5} \times n^{1.5} \times V^{0.5}$$

The variables are defined as follows: I_p is the peak current, A is the effective area of the electrode, C is the bulk concentration of Li^+ in the electrode, $D_{Li+}^{0.5}$ is the Li^+ diffusion coefficient, n is the number of electrons involved in the redox process, and V is the CV potential scan rate.

$$D_{Li+}^{0.5} = \frac{I_p}{2.59 \times 10^5 \times A \times C \times n^{1.5} \times V^{0.5}}$$

$$\text{Slope} = \frac{I_p}{V^{0.5}}$$

Due to the different values of the oxidation and reduction peaks, $D_{Li+}^{0.5}$ can be estimated more accurately by averaging the absolute values of the slopes (M_{avg}).

$$(\boldsymbol{M_{avg}}) = \frac{Oxidation\ peak\ slope + Reduction\ peak\ slope}{2}$$

For instance, the slope of LFP-MF is 4.1376×10^{-4}, and LFP-WMF is 2.143×10^{-4}.

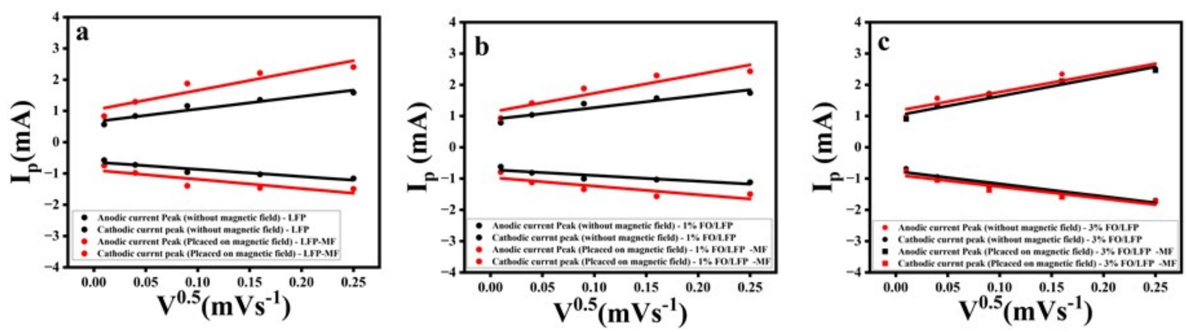

Fig. S2. Relationship between I_p and $V^{0.5}$ established using CV curves for (**a**) LFP and LFP-MF; (**b**) 1%FO/LFP and 1%FO/LFP-MF; and (**c**) 3%FO/LFP and 3%FO/LFP-MF

<u>Table S1: SEM Cross-Sectional thickness and TEM Freeze-dried Fe_2O_3 particle size calculation</u>

S/N	LFP-WMF (µm)	LFP-MF (µm)	LFP+1% Fe_2O_3-WMF (µm)	LFP+1% Fe_2O_3-MF (µm)	LFP+3% Fe_2O_3-WMF (µm)	LFP+3% Fe_2O_3-MF (µm)	Freeze-dried Fe_2O_3 (nm)
Sample 1	15.01	14.24	15.75	13.29	18.5	17.65	91.27

Sample 2	15.56	14.91	13.84	12.51	13.28	12.16	94.06
Sample 3	17.33	15.75	18.15	16.71	17.4	16.98	82.84
Sample 4	17.77	15.38	15.49	14.5	17.2	15.95	96.12
Sample 5	17.08	18.98	15.18	14.63	16.75	16.97	91.30
Average	16.55 ± 0.54	15.85 ± 0.82	15.68 ± 0.70	14.33 ± 0.71	16.63 ± 0.88	15.94 ± 0.98	91.18 ± 2.26

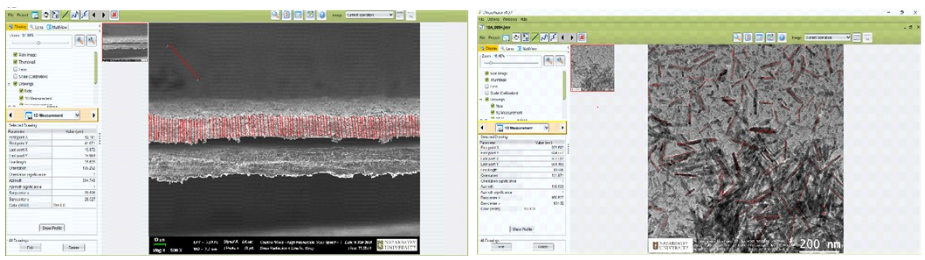

Fig. S3. (a) SEM cross-sectional thickness and (b) TEM freeze-dried FO particle size calculation. JMicroVision software (v1.3.4).

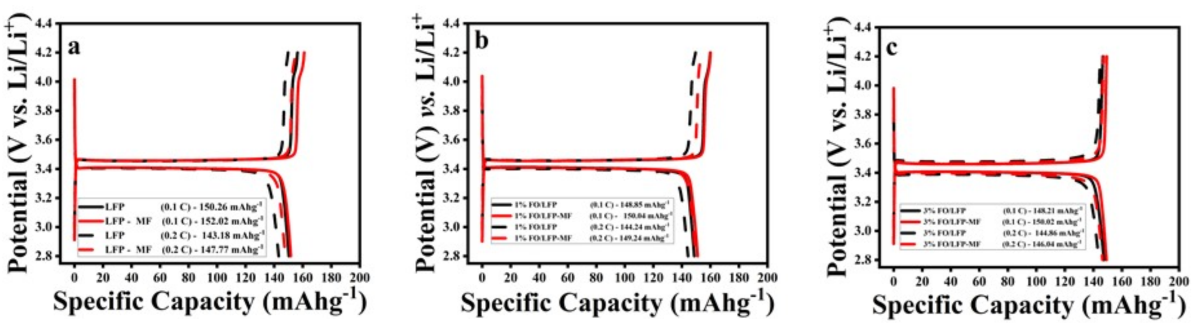

Fig. S4. Potential profiles for LFP cathodes at 0.1 and 0.2 C using the 4th cycle: (a) LFP and LFP-MF; (b) 1%FO/LFP and 1%FO/LFP-MF; (c) 3%FO/LFP and 3%FO/LFP-MF.

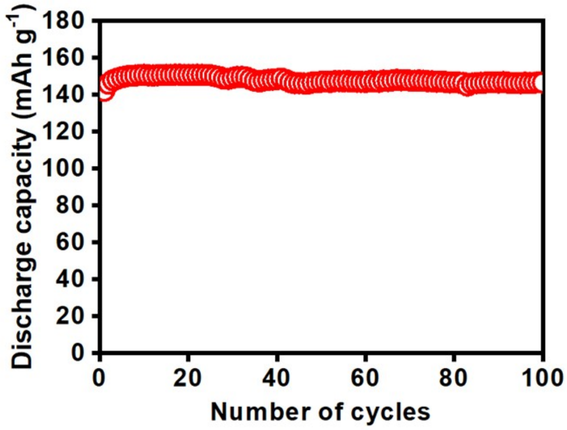

Fig. S5. Prolonged Cycling Performance of 1% FO/LFP-MF at 0.2 C.

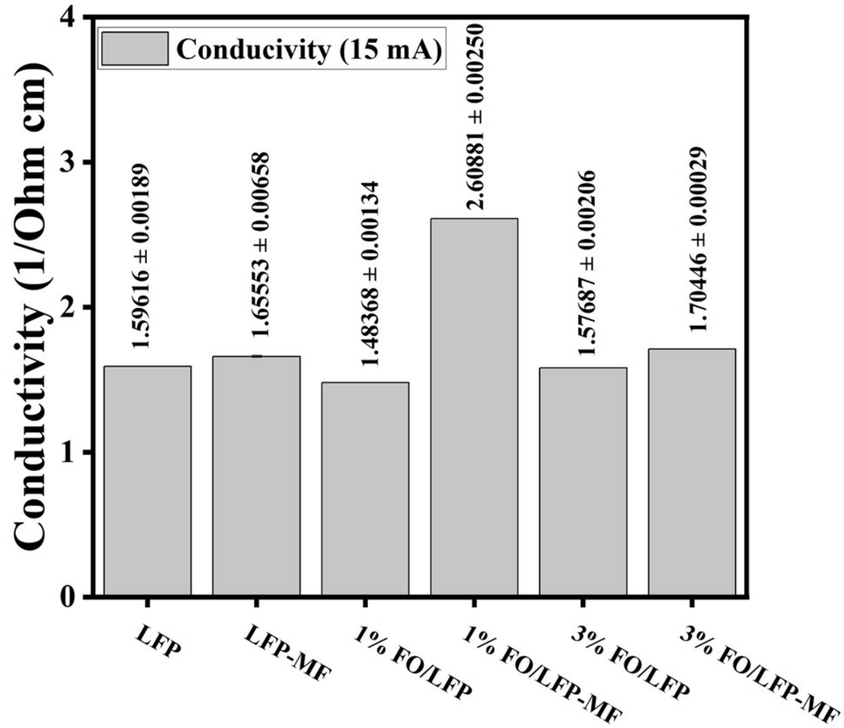

Fig.S6. Hall effect measurement results of LFP, 1% FO/LFP and 3% FO/LFP samples with/without MF at 15 mA