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Supporting Information

Bio-inspired synthesis of N, F co-doped 3D graphitized carbon foams containing manganese fluoride nanocrystals for lithium ion batteries

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Materials and methods

Preparation of c-MnF_2 @N,F-C control anode

Commercial MnF_2 was purchased from Strem Chemicals UK, Ltd.. N,F-C was prepared using our method. The content of commercial MnF_2 in c-MnF_2@ N,F-C mixture was the same with that in MnF_2@N,F-C (25%).The working electrodes were prepared by coating the slurry of the physical mixture (commercial MnF_2, N,F-C) (90 wt%) and polyvinylidene fluoride (PVDF) (10 wt%) dissolved in n-methyl pyrrolidinone (NMP) onto a copper foil substrate and dried in a vacuum oven at 80°C for 2 days. The mass loading of the active material (physical mixture of commercial MnF_2 and N,F-C) in the electrode is about 1.2 mg cm^{-2}.

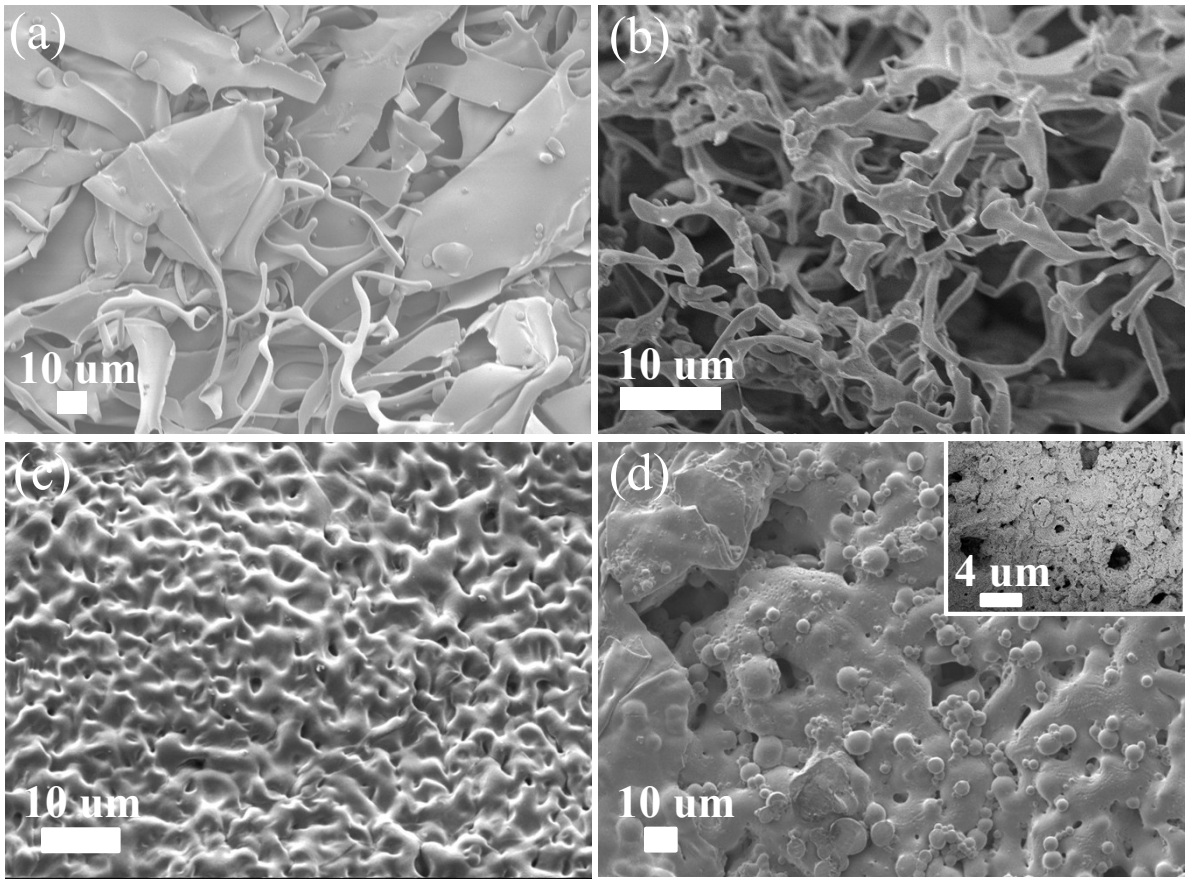

Fig. S1 SEM images of (a) lyophilized ELK16-FLAG protein and (b) crosslinked ELK16-FLAG scaffold; SEM images of (c) crosslinked ELK16-FLAG scaffold treatment with ionic liquid (IL, 4h), Mn^{2+} (4h) and IL (overnight); SEM images of crosslinked ELK16-FLAG hydrogel after treatment with Mn^{2+} (4h)/ IL (4h) /Mn^{2+} (overnight) before (d) and after annealing (inset of d) at 600°C for 4h in Argon atmosphere.

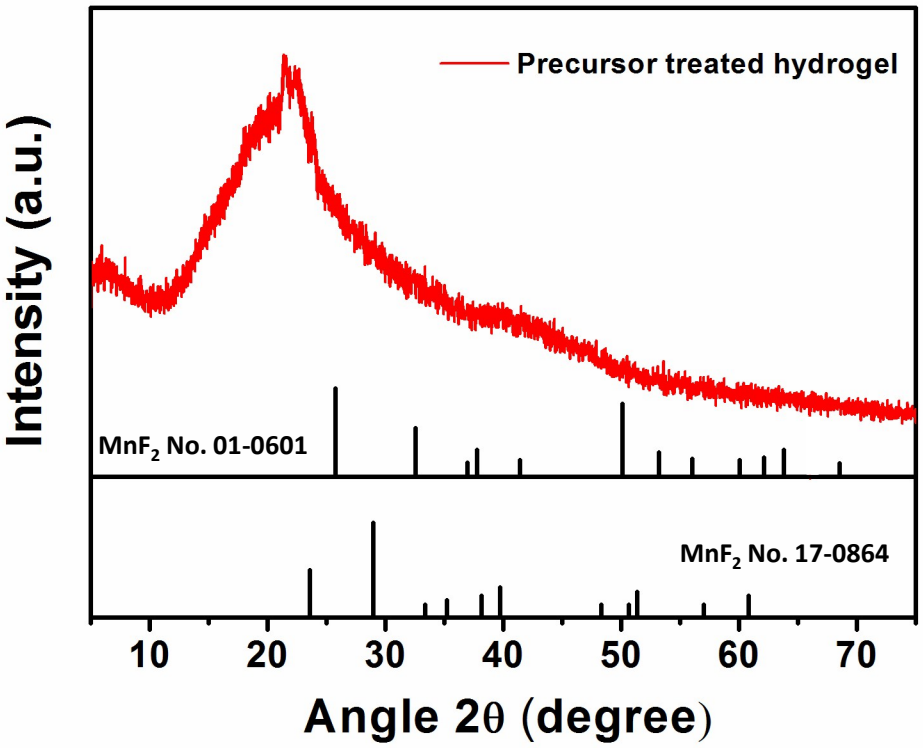

Fig. S2 XRD patterns of ELK16-FLAG hydrogel treated with ionic liquid (IL, 4h), Mn^{2+} (4h) and IL (overnight) before annealling.

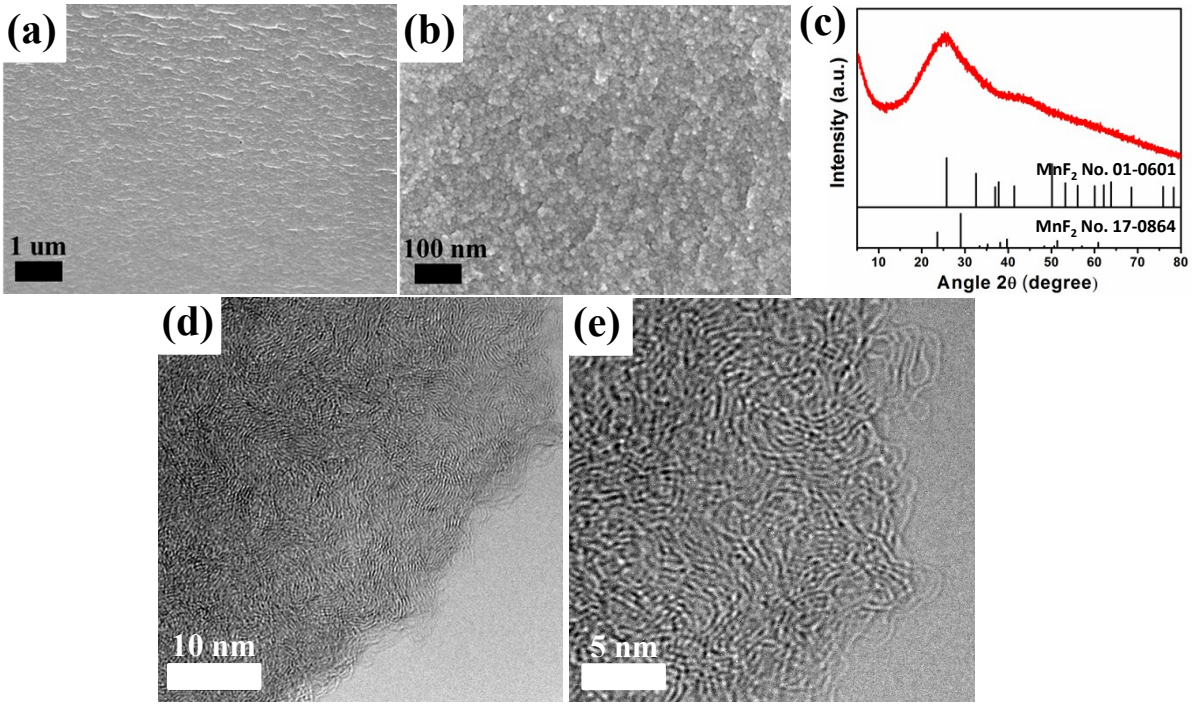

Fig. S3 (a-b) SEM images and (c) XRD patterns of the sample prepared using crosslinked ELK16 control as the starting scaffold. (d-e) TEM images of the annealed sample showing a dense crystallized carbon matrix, where MnF_2 crystallites were clearly absent. Lattice spacings measured in (e) correspond to that of graphitized carbon.

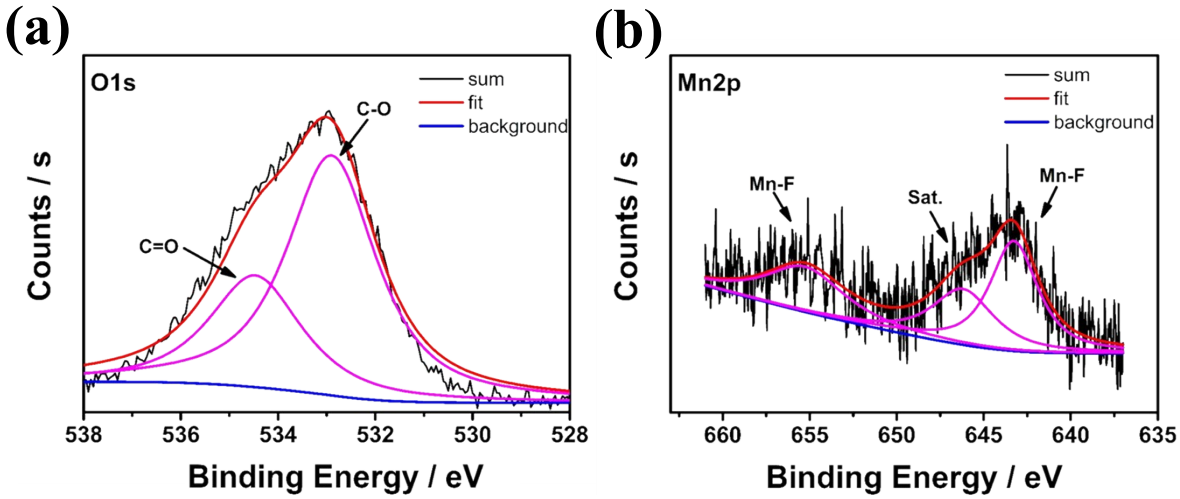

Fig. S4 XPS spectrums of O1s (a) and Mn2p (b) in MnF_2@N,F-C.

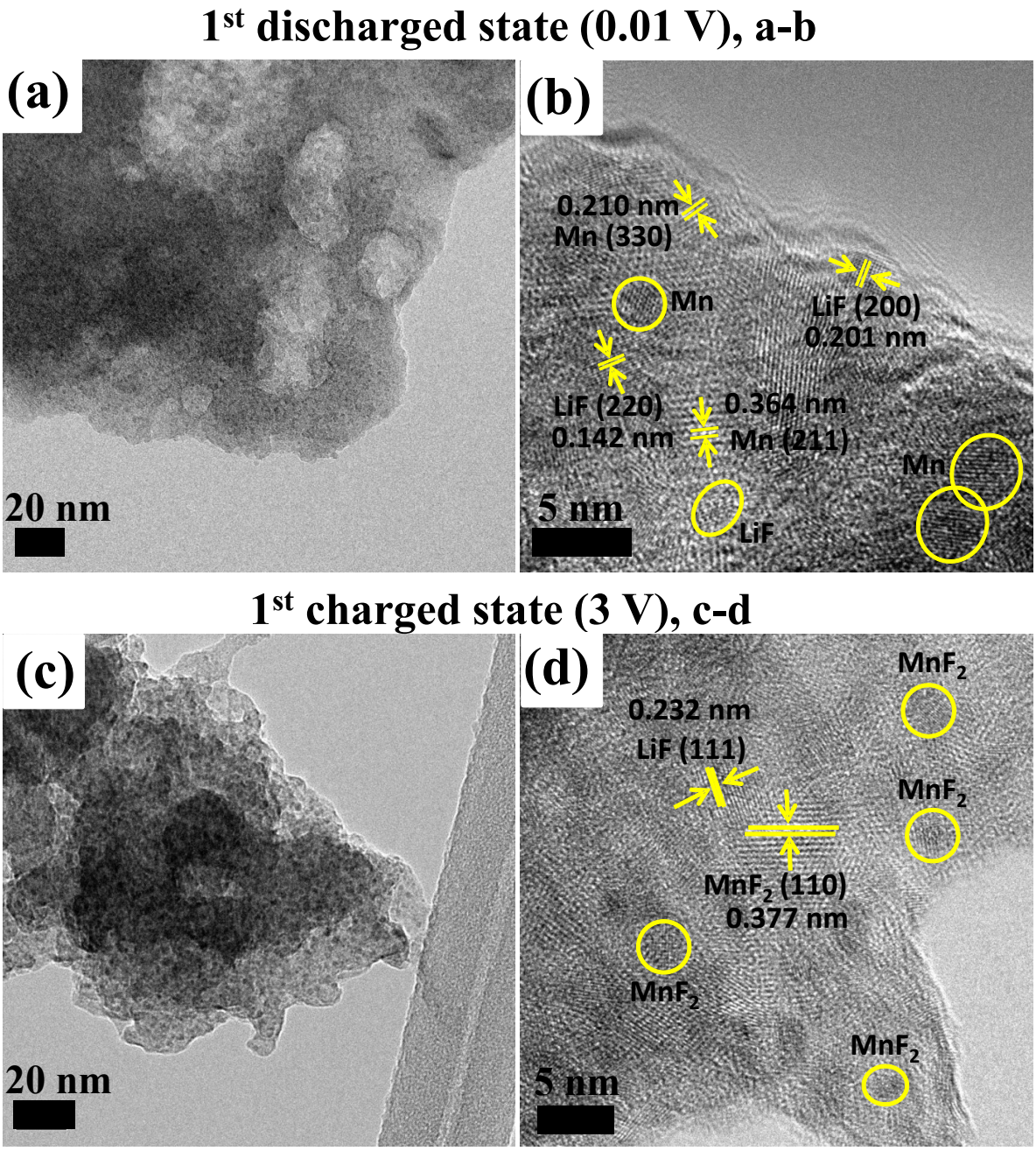

Fig.S5 Microstructural characterization of the MnF_2@N,F-C after the first cycle. (a) Representative TEM images for the MnF_2@N,F-C anode at the first discharged (lithiated) state. (b) HRTEM image confi rming the generation of LiF matrix and metallic domains. (c) Representative TEM images for the MnF_2@N,F-C anode at the first recharged (delithiated) state. (d) HRTEM image confirming the regeneration of MnF_2 nanocrystallines.

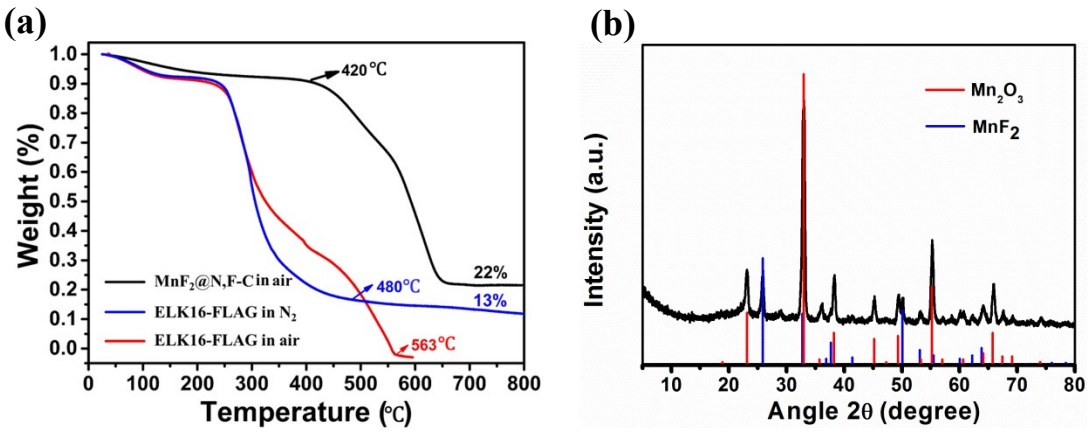

Fig. S6 (a) TGA curves of MnF_2@ N,F-C (black surve) in air, ELK16-FLAG hydrogel in N_2 (blue curve) and ELK16-FLAG hydrogel in air (red curve); (b) XRD pattern of MnF_2@ N,F-C sample after annealled in air using the same temperature program as that of TGA testing for MnF_2@ N,F-C (black curve in (a)) sample.

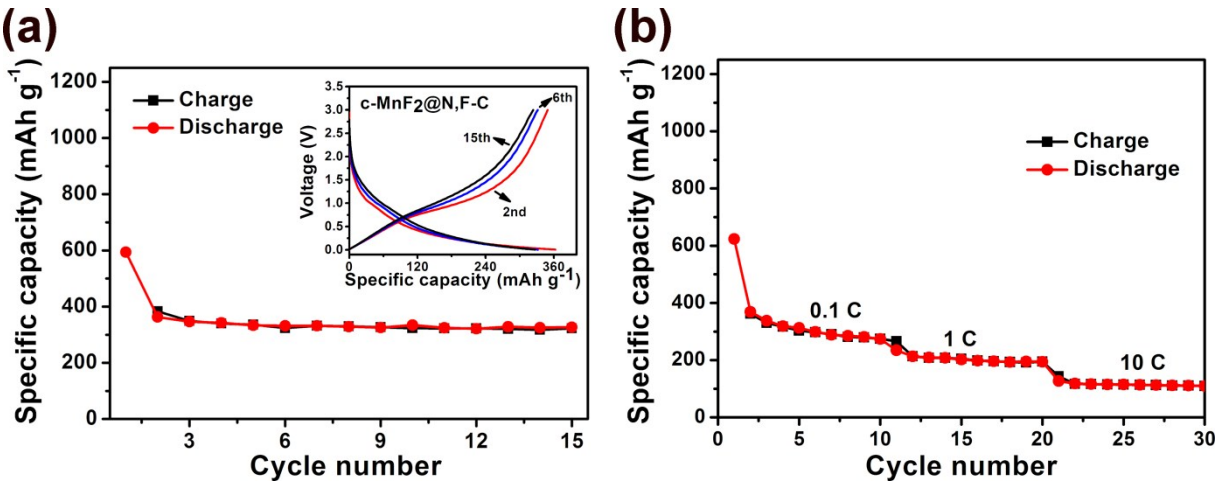

Fig.S7 Electrochemical characteristics of the c-MnF_2 @N,F-C control anode. (a) cycling performance at a rate of 0.1 C. Inset of (a) shows the 2nd, 6th and 15th galvanostatic charge/discharge curves of c-MnF_2 @N,F-C control; (b) rate performance at different rates for c-MnF_2 @N,F-C control anode.