Electronic Supplementary Material (ESI) for Journal of Materials Chemistry A.


**Supporting Information**

# Bio-inspired multiscale-pore-network structured carbon felt with enhanced mass transfer and activity for vanadium redox flow batteries

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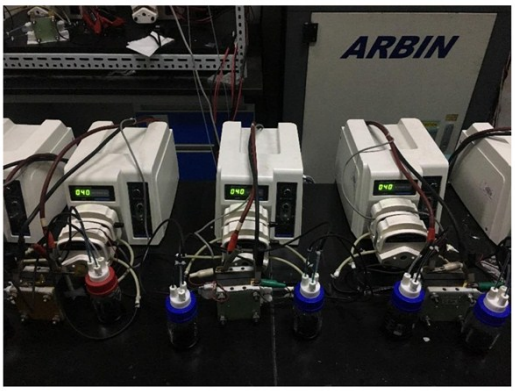


**Figure S1** Digital picture of the vanadium redox flow battery setups in this work.

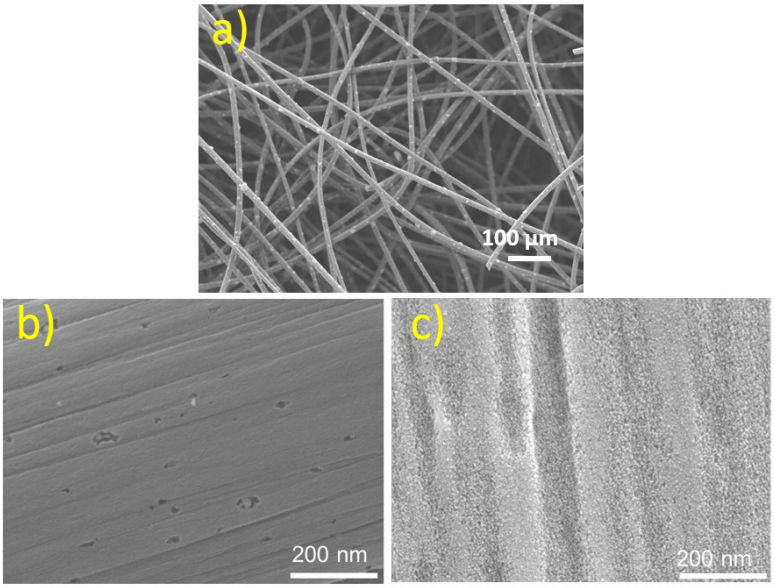


**Figure S2** SEM images of a) CF-ZnO-5, b) CF-pristine and c) CF-air.

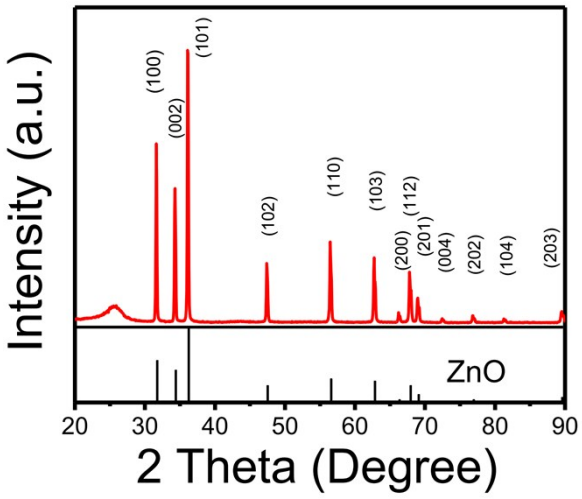


**Figure S3** XRD patterns of CF-ZnO-5.

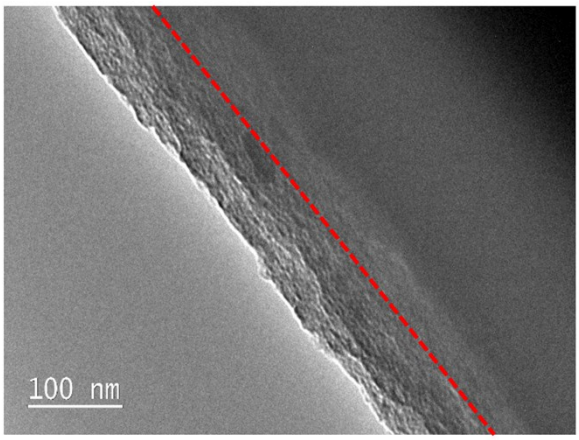


**Figure S4** TEM image of MPNCF-5.

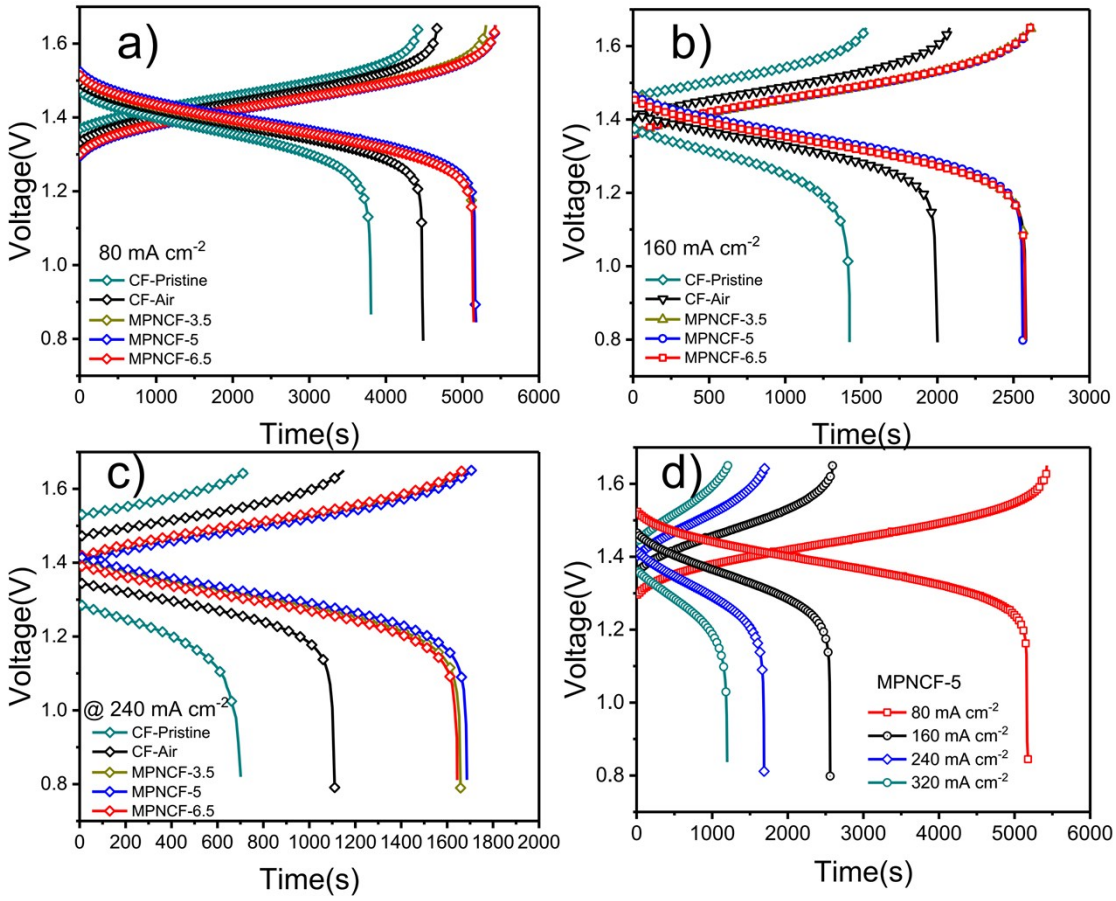


**Figure S5** Charge-discharge curves of batteries with different types of electrodes at a) 80 mA $cm^{-2}$, b) 160 mA $cm^{-2}$, and c) 240 mA $cm^{-2}$; d) charge-discharge curves of battery with MPNCF-5 at different current densities.

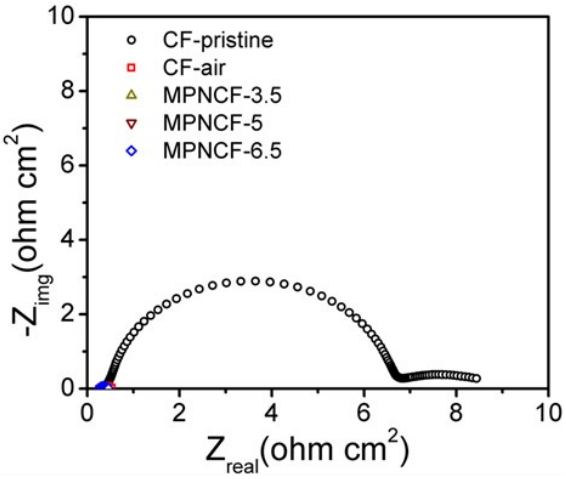


**Figure S6** Electrochemical impedance spectra of batteries with different types of electrodes at various current densities

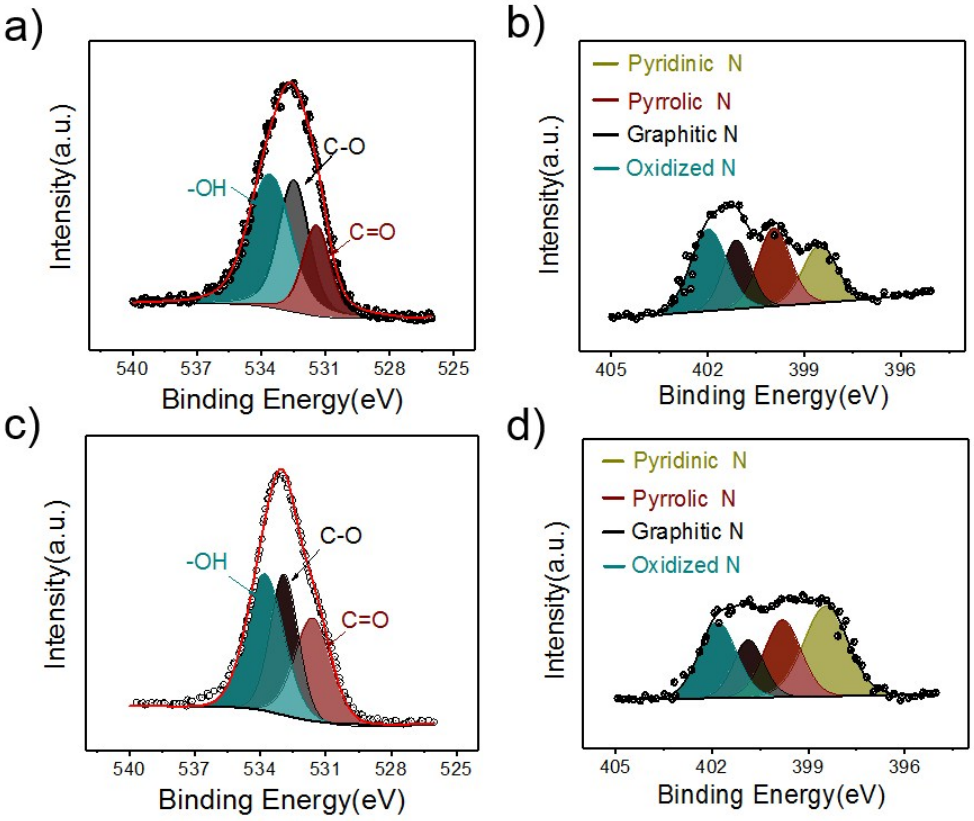


**Figure S7** XPS results from MPNCF-5 electrodes (after cycling test) in the O 1s for the negative electrode (a), N 1s for the negative electrode (b), the O 1s for the positive electrode (c), and N 1s for the positive electrode (d).

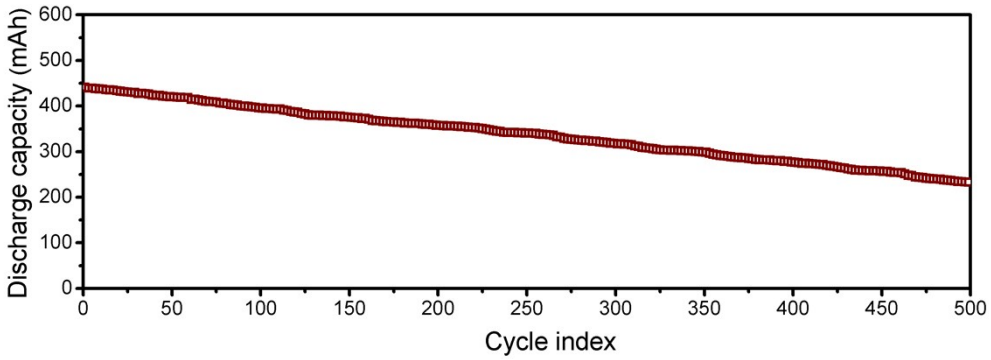


**Figure S8** Discharge capacity of battery with MPNCF-5 electrodes at 320 mA $cm^{-2}$ during 500 cycles.

**Table S1** Summary of performance of VRFB with improved electrode in the open literature

| Electrode materials used | Feature | Current density (mA $cm^{-2}$) | Energy efficiency (%) | References |
|---|---|---|---|---|
| Carbon paper | $WO_3$ | 50 | 80.5 | 15 |
| Carbon paper | $CO_2$ | 140 | 78.1 | 16 |
| Graphite felt | Bi | 150 | 78 | 17 |
| Graphite felt | $Nb_2O_5$ | 150 | 77.6 | 18 |
| Graphite felt | $ZrO_2$ | 250 | 62.1 | 19 |
| Graphite felt | Corn protein-derived carbon | 150 | 68.6 | 20 |
| Carbon paper | Mixed acid | 40 | 65.4 | 21 |
| Graphite felt | Sn | 150 | 77.3 | 24 |
| Carbon felt | Graphene-nanowall | 125 | 76 | 28 |
| **Carbon felt** | **Multiscale pore-network structure** | **320** | **81.9** | **This work** |

**Table S2** Species concentrations of different electrodes obtained by XPS results.

| Components | MPNCF-5 | MPNCF-5 (500 Cycles) Negative side | MPNCF-5(500 Cycles) Positive side |
|---|---|---|---|
| C 1s(%) | 90.44 | 88.10 | 88.53 |
| O 1s(%) | 7.58 | 10.02 | 9.89 |
| N 1s(%) | 1.98 | 1.88 | 1.95 |
| C=O(%) | 2.43 | 1.75 | 1.86 |
| C-O(%) | 1.79 | 2.43 | 2.39 |
| C-O-(%) | 3.36 | 5.84 | 5.64 |