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Supporting Information

A robust esterified nanofibre electrode for proton exchange membrane fuel cells

Manman Qi [a, b], Ming Hou [* a], Yachao Zeng [a], Yanyan Gao [a, b], Yue Yang [a, b], Liang He [a, b], Haiping Chen [a, b], Hongjie Zhang [a], Wei Song [a], Zhigang Shao [* a]

a. Fuel Cell System and Engineering Laboratory, Dalian Institute of Chemical Physics, Chinese Academy of Sciences, Dalian, Liaoning 116023, China.

b. University of Chinese Academy of Sciences, Beijing 100049, China.

**Corresponding Authors:*

Email: houming@dicp.ac.cn, zhgshao@dicp.ac.cn.

Fax: +86-411-84379185; Tel: +86-411-84379051, +86-411-84379153.

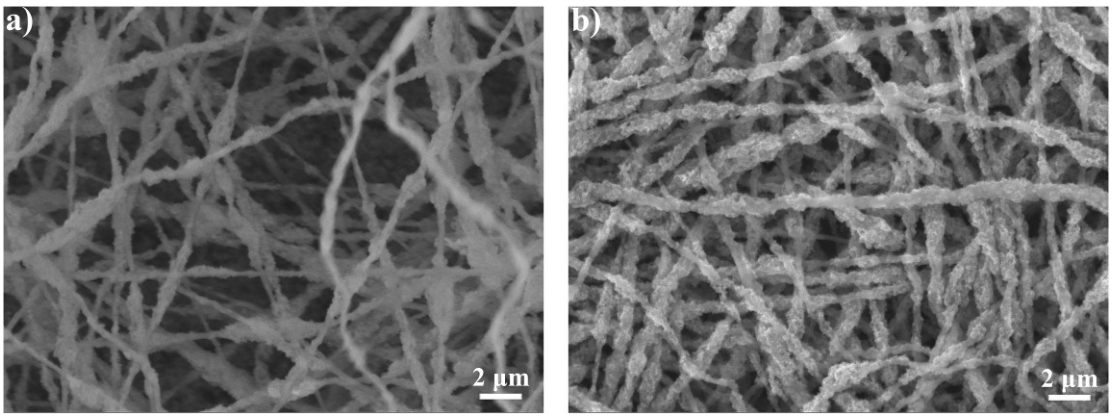

Fig. S1. The SEM images of the nanofibre electrode a) before and b) after the decal process.

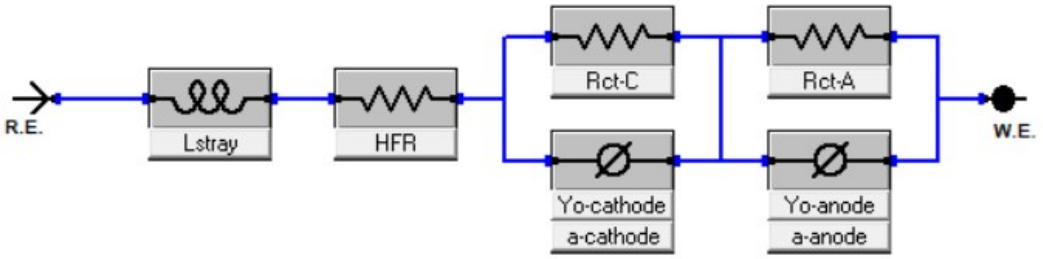

Fig. S2. The equivalent circuit modeling for fitting the electrochemical impedance spectra data at different current densities.

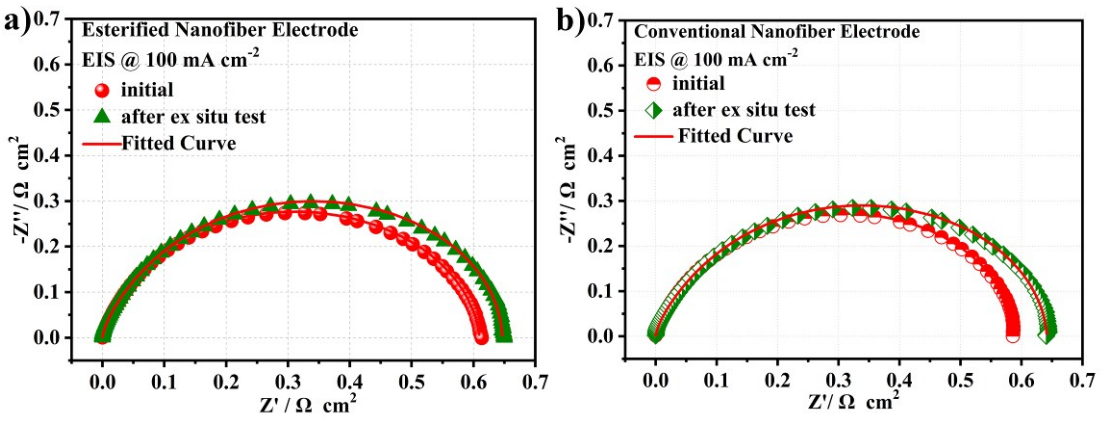

Fig. S3. Electrochemical impedance spectra of nanofibre electrodes before and after the *ex situ* test. a) The esterified nanofibre electrode b) conventional nanofibre electrode (Test condition: H_2/air with gas flow rates of 125/800 mL min^{-1} at a current density of 100 mA cm^{-2}).

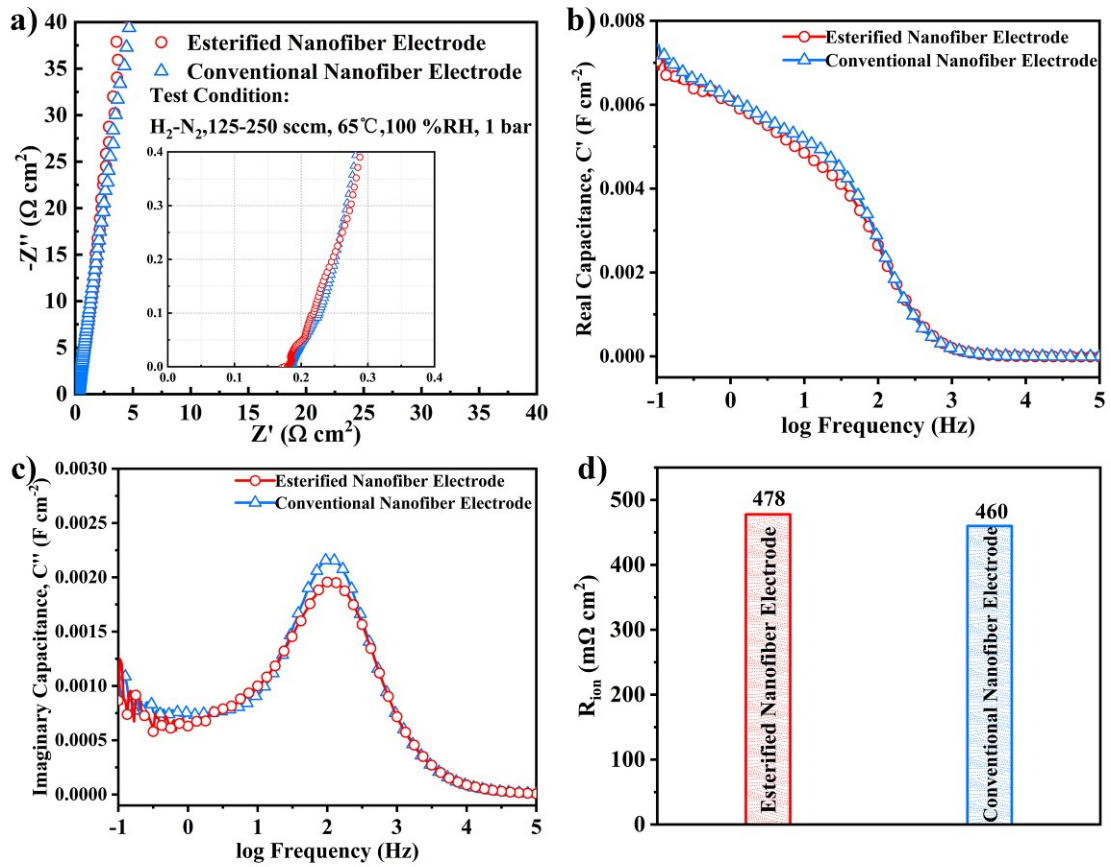

Fig. S4. Electrochemical impedance spectra of the esterified nanofibre electrode (red circle) and the conventional nanofibre electrode (blue triangle). a) Nyquist plots, b) real capacitance plots, c) imaginary capacitance plots and d) the calculating R_{ion}. The test was performed at 0.4 V, H_2/N_2 with gas flow rates of 125/250 mL min^{-1}, the cell temperature was 65 ° C ,100% RH, 1 bar.

The ionic resistance in the cathode is derived from a complex capacitance analysis.[1, 2] The complex capacitance can be expressed as[3, 4]

$$C(f)=\frac{1}{j2\pi fZ(f)}=\frac{1}{2\pi f[jZ'(f)-Z''(f)]}=-\frac{Z''(f)}{2\pi f\,|Z(f)|^2}-j\frac{Z'(f)}{2\pi f\,|Z(f)|^2} \quad \text{* MERGEFORMAT (1)}$$

$$C'(f)=-\frac{Z''(f)}{2\pi f\,|Z(f)|^2} \quad \text{* MERGEFORMAT (2)}$$

$$C''(f)=-\frac{Z'(f)}{2\pi f\,|Z(f)|^2} \quad \text{* MERGEFORMAT (3)}$$

where C'(f) is the real capacitance and C''(f) is the imaginary capacitance. The double layer capacitance C_{dl} is calculated by numerical integration of C''(f) with respect to log f as follows

$$Area=\int_{-\infty}^{\infty}C''(f)d\log f=0.682C_{dl} \quad \text{* MERGEFORMAT (4)}$$

The ionic resistance R_{ion} can calculated from the following equation

$$f_p=\frac{0.404}{\tau_{1,\max}}=\frac{0.404}{R_{ion}C_{dl}} \quad \text{* MERGEFORMAT (5)}$$

where peak frequency f_p corresponds to the peak in **Fig. S4 c)**.

Table S1. Electrochemical impedance parameters of the esterified nanofibre electrode and the conventional nanofibre electrode.

Samples	Integrated Area /mF cm^{-2}	f_p /Hz	C_{dl} /mF cm^{-2}	R_{ion} /mΩ cm^2
ENE	4.8	119	7.1	478
CNE	5.0	119	7.4	460

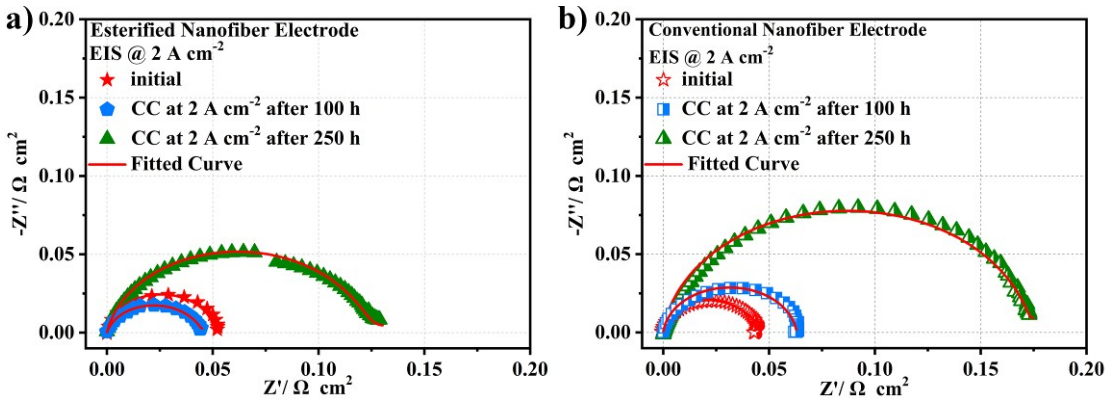

Fig. S5. Electrochemical impedance spectra of nanofibre electrodes before and after the *in situ* test. a) The esterified nanofibre electrode and b) the conventional nanofibre electrode in H_2/ O_2 condition with gas flow rates of 125/250 mL min^{-1} at a current density of 2 A cm^{-2}.

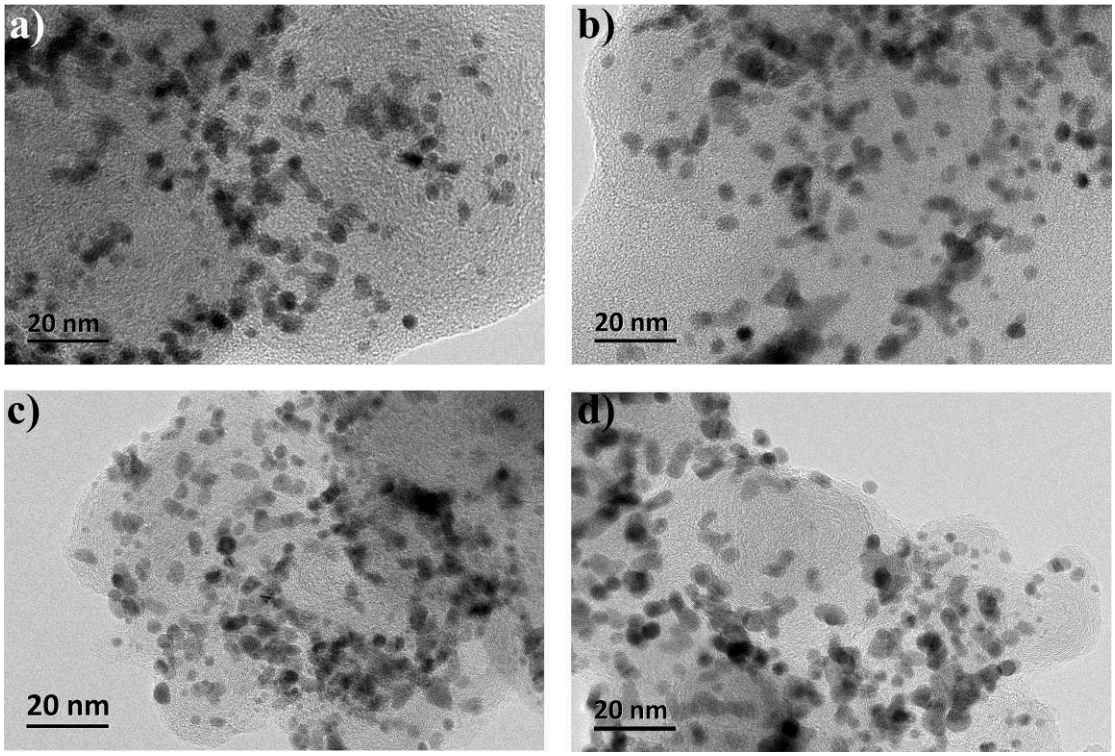

Fig. S6. TEM images of the esterified nanofibre electrode a) before and b) after the *in situ* operation. TEM images of conventional nanofibre electrode c) before and d) after the *in situ* operation.

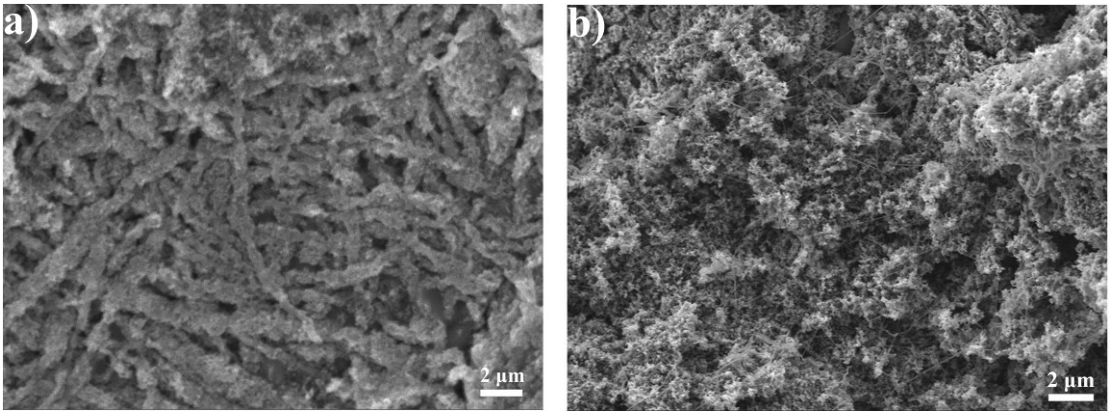

Fig. S7. SEM images of the a) esterified nanofibre electrode and b) conventional nanofibre electrode after the *in situ* stability test.

References

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