Supporting Information

Enhanced Conductivity of Anion Exchange Membrane by Incorporation of Quaternized Cellulose Nanocrystal

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Table S1. The proportion of QCNC and QPPO in membranes preparation.

Sample	QCNC (g)	QPPO (g)	DMSO (mL)
QPPO	0	0.5	0
0.5 wt% QCNC/QPPO	0.0025	0.4975	30
1 wt% QCNC/QPPO	0.005	0.495	30
2 wt% QCNC/QPPO	0.01	0.49	30
3 wt% QCNC/QPPO	0.015	0.485	30
4 wt% QCNC/QPPO	0.02	0.48	30

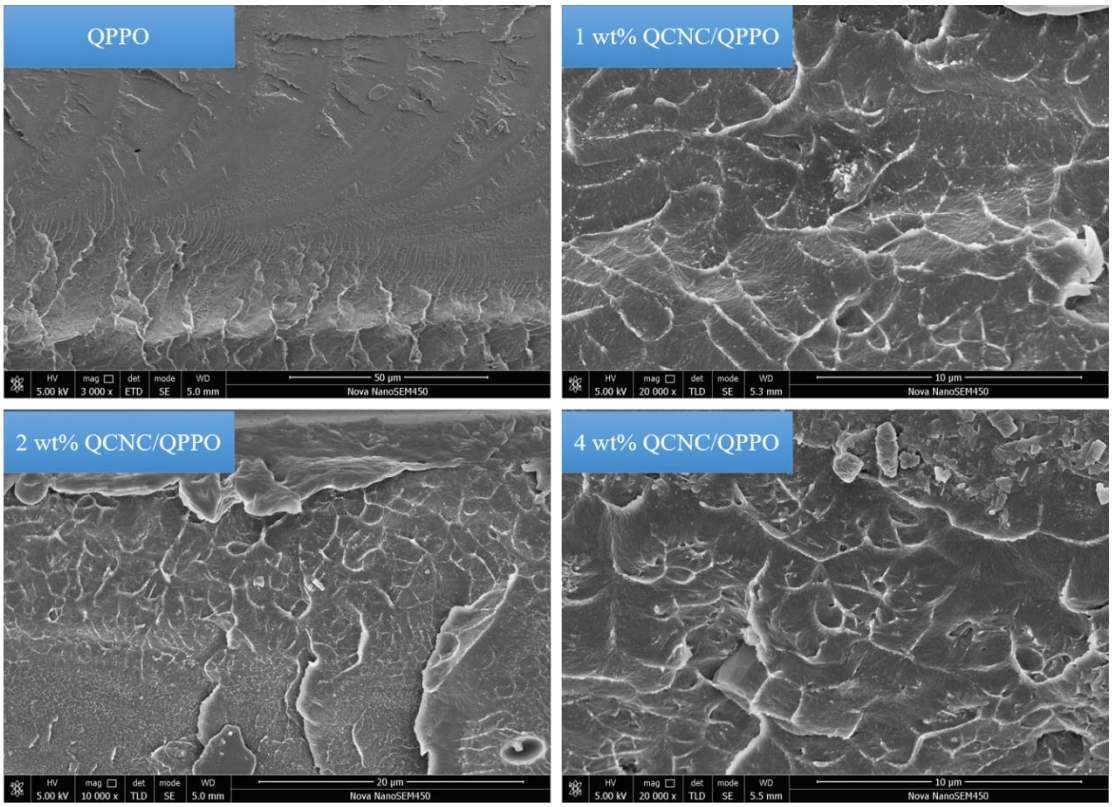

Figure S1. SEM pictures of the fracture surfaces of QPPO and QCNC/QPPO composite membranes.

The AEMs in this work are all dense membranes without pore, used for H_2/O_2 fuel cell. From the SEM pictures, one cannot observe any QCNC in composite membranes, indicating the good dispersion of QCNC without severe aggregation.

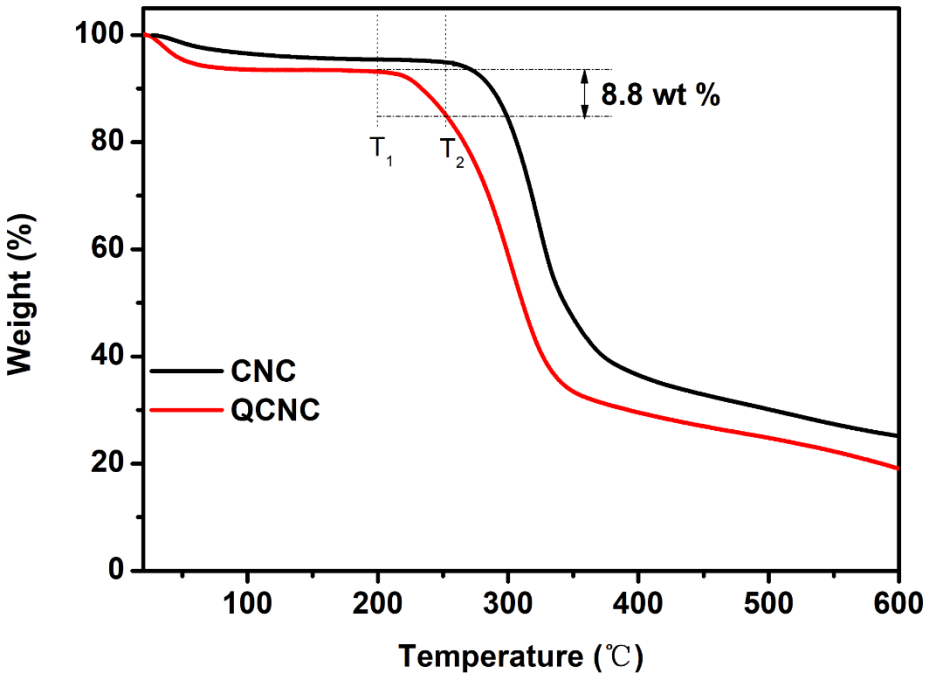

Figure S2. Estimation of the content of quaternary ammonium groups in QCNC from TGA curves.

T_1 is the initial decomposition temperature of QCNC, which can be attributed to the decomposition of quaternary ammonium groups on QCNC surface. T_2 is the initial decomposition temperature of CNC, which can be ascribed to the decomposition of unstable hydroxyl in CNC, this temperature can be regarded as the end point of quaternary ammonium groups decomposition approximately. Therefore, the quaternary ammonium groups content could be roughly calculated, by the weight loss of QCNC between T_1 and T_2. The content was calculated to be 8.8 wt%. Technically, this calculation is rough, for it is hard to determine the end temperature of quaternary ammonium groups decomposition in QCNC curve.

Similar estimation can be calculated according to the C and N atom percentage from XPS result. With a N atom percentage of 1.6 %, the quaternary ammonium groups content was calculated to be ca. 8.9 wt%. Note that, it is not very precise to quantitatively analyze the atom ratio in XPS, thus this calculation was also rough.

Combination of the two methods to determine the quaternary ammonium groups content in QCNC, we take an average value of ca. 8.85 wt%.

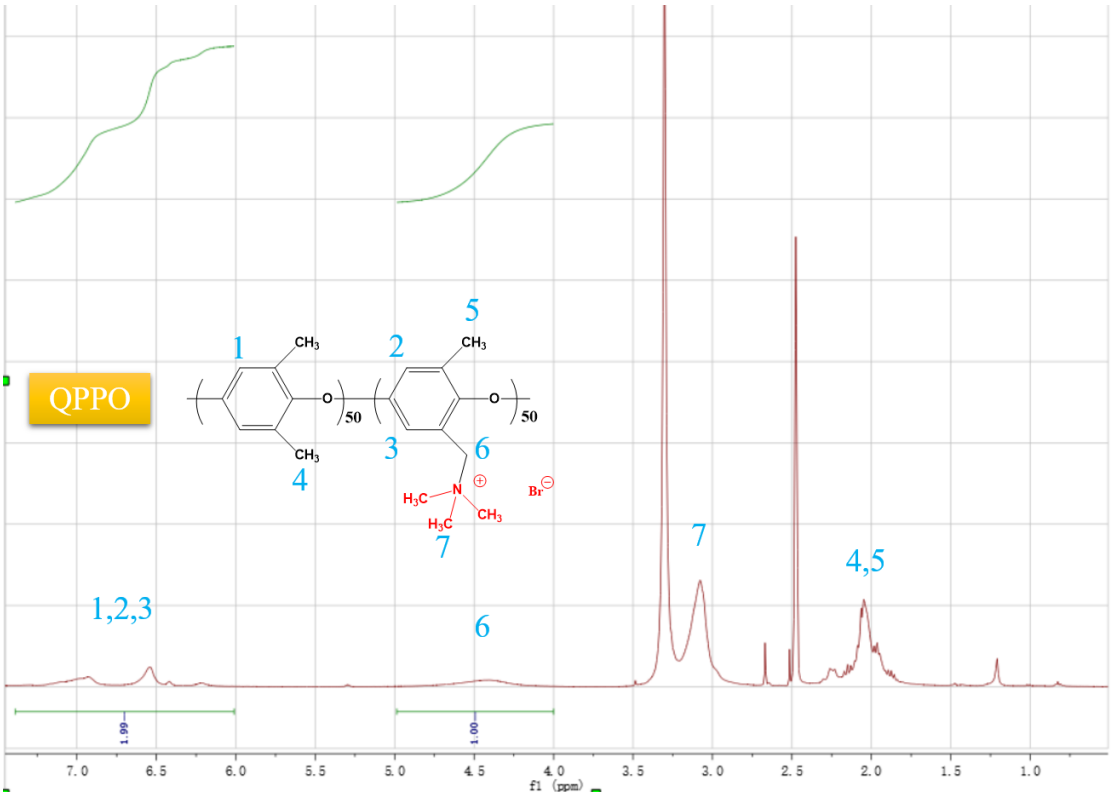

Figure S3. The ^{1}H NMR of QPPO for ionomer.

According to the integration from NMR data, the quaternization degree of QPPO was 50 %.

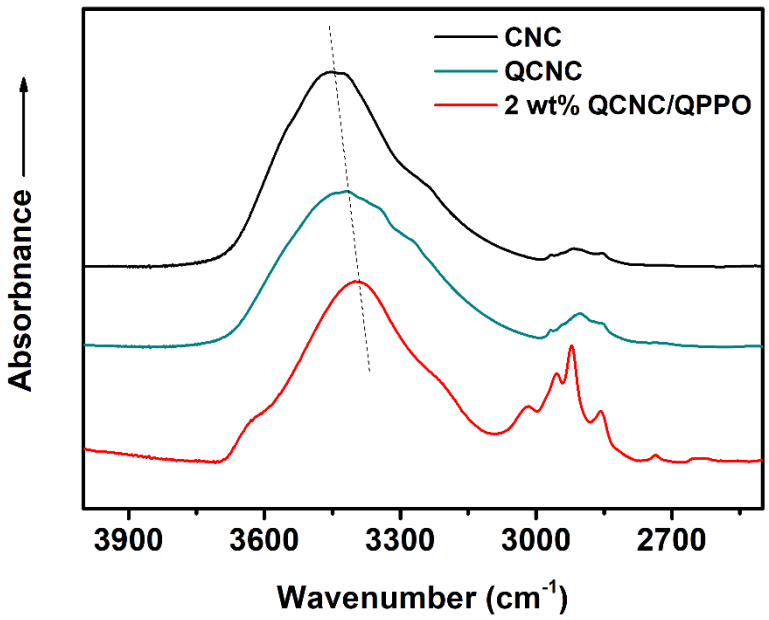

Figure S4. FTIR spectrum of CNC, QCNC and 2 wt% QCNC/QPPO.

The characteristic peak at 3448 cm^{-1} of CNC was ascribed to the hydroxyl, after surface modified with silane, it slightly shifted to 3420 cm^{-1} for QCNC. While for 2 wt% QCNC/QPPO, the hydroxyl peak emerged at 3340 cm^{-1}, which showed a "red shift" of 80 cm^{-1}, compared with QCNC. This prominent red shift in FTIR indicated that there was good interaction between QCNC and QPPO matrix.