ELECTRONIC SUPPLEMENTARY INFORMATION FOR

New nanocomposite proton conducting membranes based on a core-shell nanofiller for low relative humidity fuel cells

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Table S1. Phases contained within the ZrTa filler nanoparticles determined by analyzing the electron diffraction pattern shown in Figure 1(c).

Interplanar Distance (Å)		Component	Lattice	Space Group	Miller Index
Measured Values	Literature Values[1]				
3.79	3.77	Ta_2O_5	Face-centered Monoclinic	F	1 1 1
3.15	3.16	m-ZrO_2	Primitive Monoclinic	$P2_1/c$ (14)	-1 1 1
3.04	3.04	Ta_2O_5	Face-centered Monoclinic	F	1 1 7
3.00	3.00	Ta_2O_5	Face-centered Monoclinic	F	0 0 12
2.95	2.95	t-ZrO_2	Primitive Tetragonal	$P4_2/nmc$ (137)	1 0 1
2.64	2.62	m-ZrO_2	Primitive Monoclinic	$P2_1/c$ (14)	0 0 2
2.24	2.25	Ta_2O_5	Face-centered Monoclinic	F	0 0 16
1.85	1.81	t-ZrO_2	Primitive Tetragonal	$P4_2/nmc$ (137)	1 1 2
1.57	1.55, 1.54	t-ZrO_2	Primitive Tetragonal	$P4_2/nmc$ (137)	2 1 1, 1 0 3

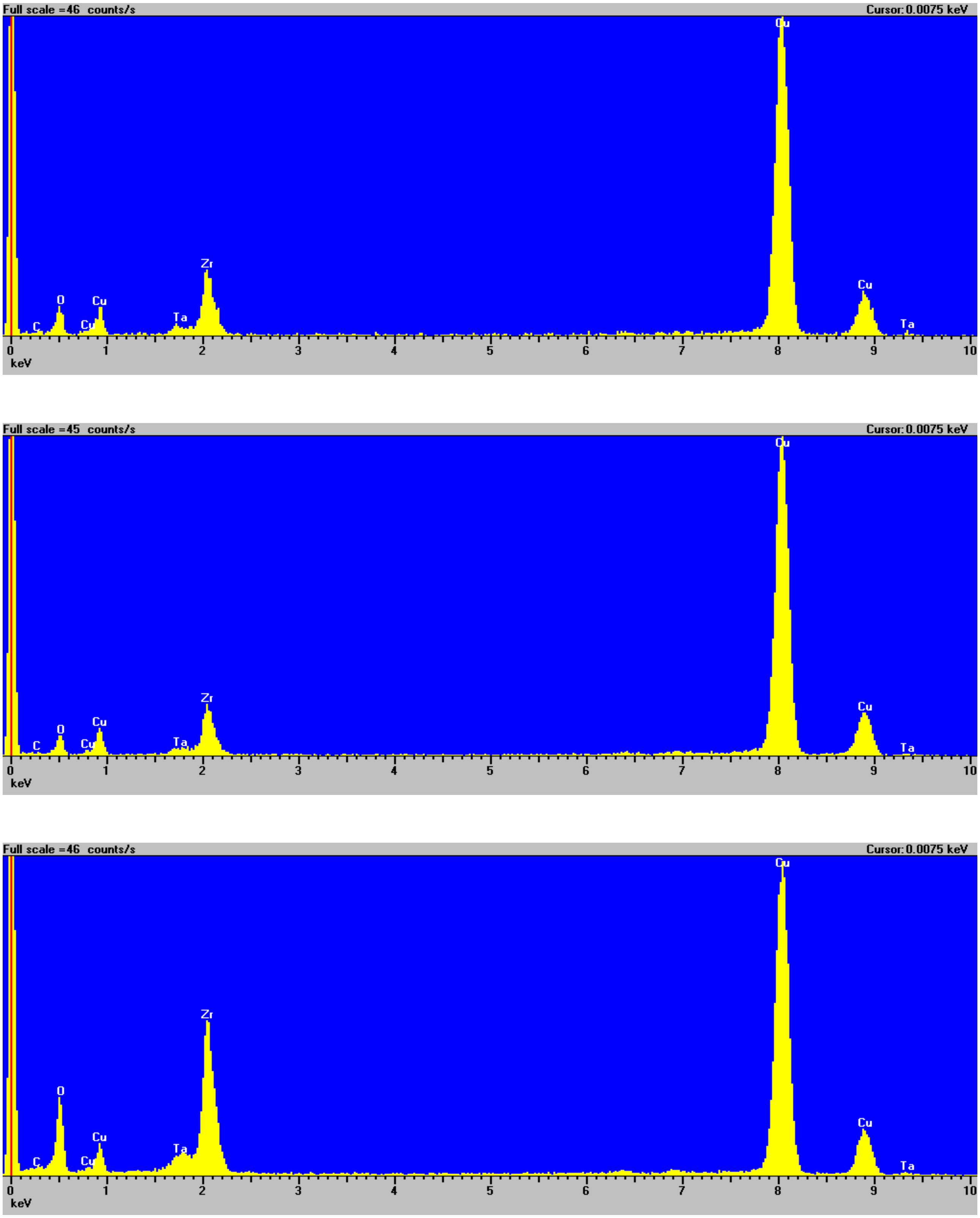

Figure S1. EDX spectra of different ZrTa filler nanoparticles.

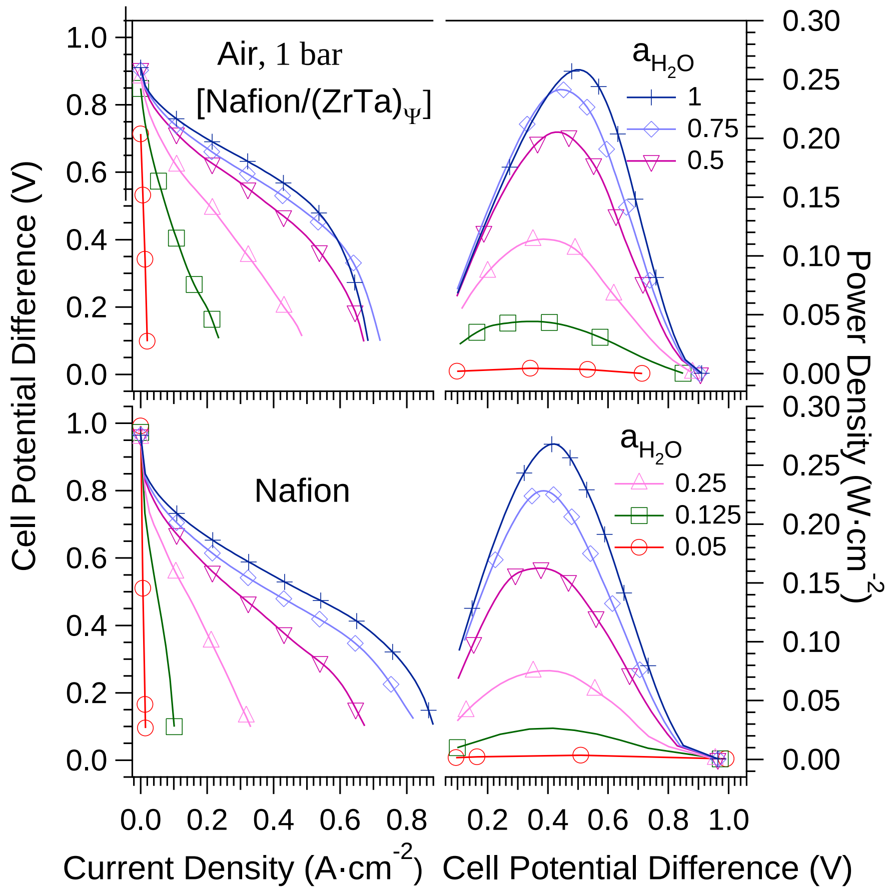

Figure S2. Polarization and power curves to illustration the single fuel cell performance of the MEAs. The oxidant is air, and the back pressure is 1 bar. The membrane thickness is ca. 110 and 140 μm for Nafion and [Nafion/(ZrTa)$_\Psi$], respectively. The data are not corrected for IR losses.

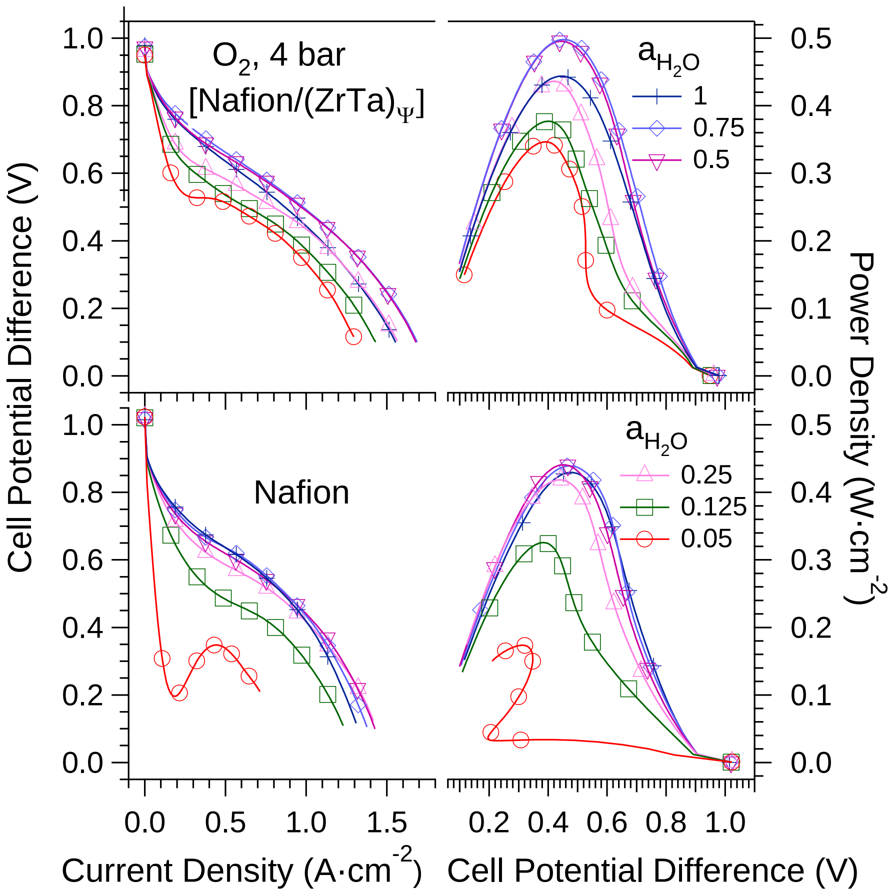

Figure S3. Polarization and power curves to illustration the single fuel cell performance of the MEAs. The oxidant is pure oxygen, and the back pressure is 4 bar. The membrane thickness is ca. 110 and 140 μm for Nafion and [Nafion/(ZrTa)$_{\Psi}$], respectively. The data are not corrected for IR losses.

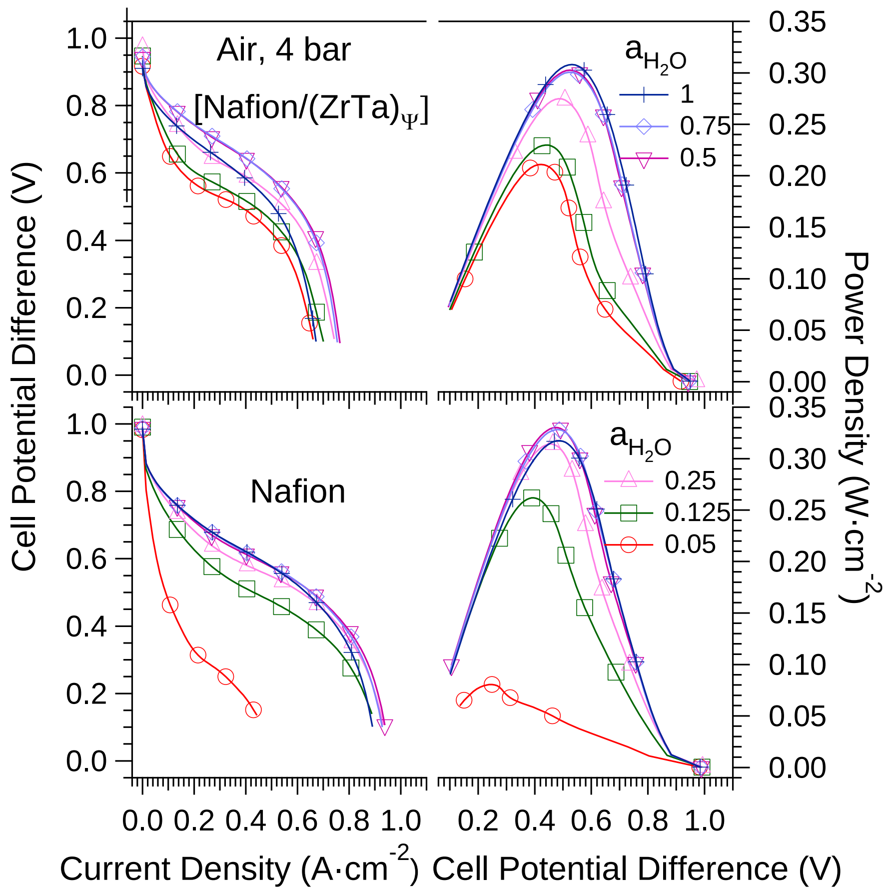

Figure S4. Polarization and power curves to illustration the single fuel cell performance of the MEAs. The oxidant is air, and the back pressure is 4 bar. The membrane thickness is ca. 110 and 140 μm for Nafion and [Nafion/(ZrTa)$_{\Psi}$], respectively. The data are not corrected for IR losses.

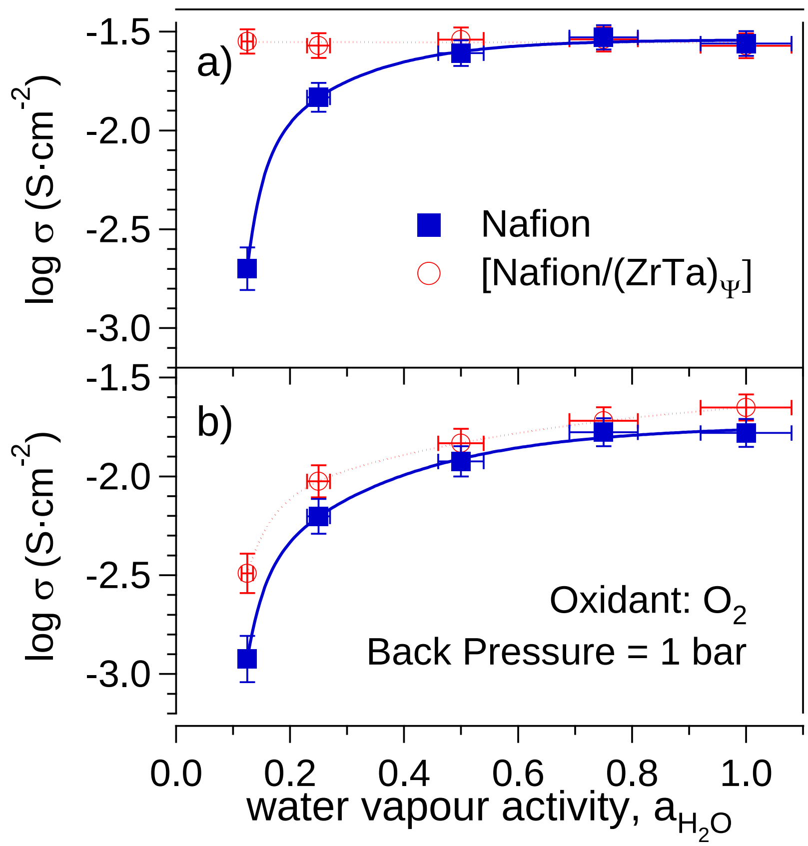

Figure S5. Dependence of the MEA conductivity on a_{H_2O} for Nafion and [Nafion/(ZrTa)$_\Psi$]. The conductivities were determined from the polarization curves: a) at the cell potential difference corresponding to the maximum of the power curve; and b) at lower current densities where the contribution of self-humidification is reduced. The back pressure was 1 bar and the oxidant was oxygen. The lines are a guide for the eye. The membrane thickness is ca. 110 and 140 μm for Nafion and [Nafion/(ZrTa)$_\Psi$], respectively. The data are not corrected for IR losses.

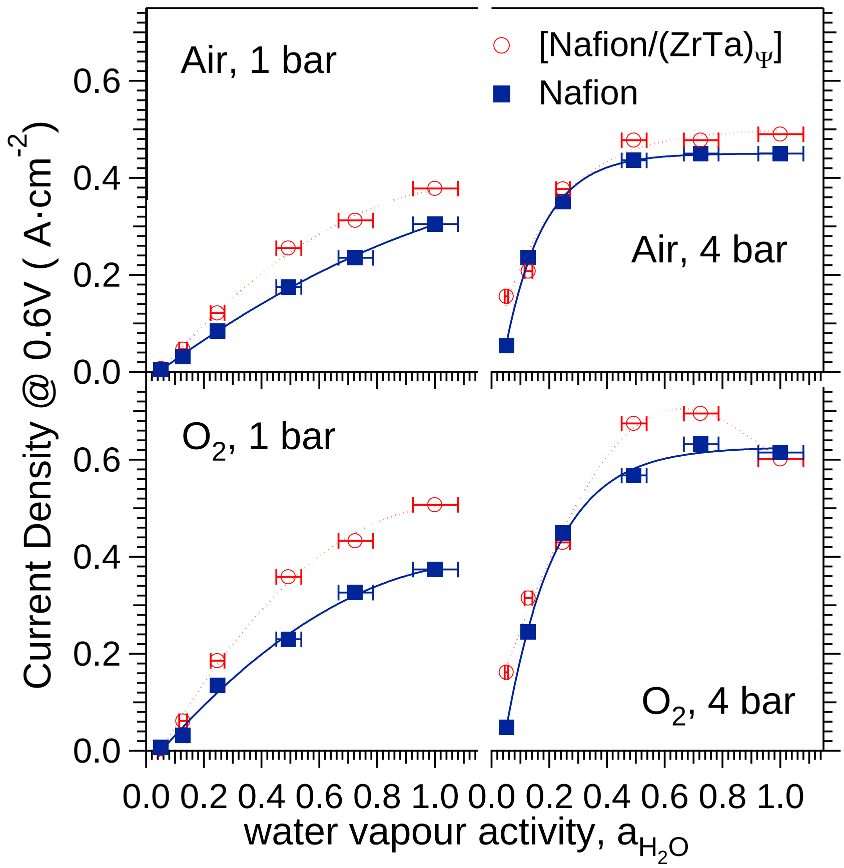

Figure S6. Dependence on a_{H_2O} of the current density values at a cell potential difference of 0.6 V. The back pressure was either 4 or 1 bar. The oxidant was either air or oxygen. The lines are meant as a guide to the eye. The membrane thickness is ca. 110 and 140 μm for Nafion and [Nafion/(ZrTa)$_{\Psi}$], respectively. The data are not corrected for IR losses.

REFERENCES

1. Powder Diffraction File, JCPDS International Centre for Diffraction Data, Swarthmore PA, PDF no. 33-1391 (Ta_2O_5), 86-1450 (m-ZrO_2), 88-1007 (t-ZrO_2).