Electronic Supplementary Information

Ultrathin AgPt Alloy Nanorods as Low-cost Oxygen Reduction Reaction Electrocatalysts in Proton Exchange Membrane Fuel Cells

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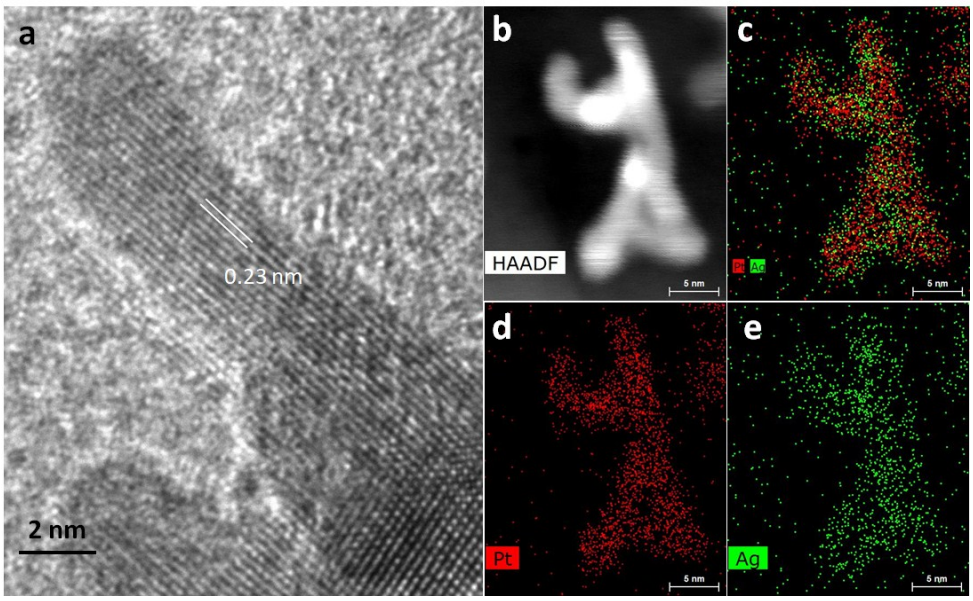

Fig. S1 a) High-resolution TEM image of Ag_1Pt_4 NR/C (atomic ratio of Ag:Pt = 1:4), **b-e)** show the element mapping by STEM-EDX analysis.

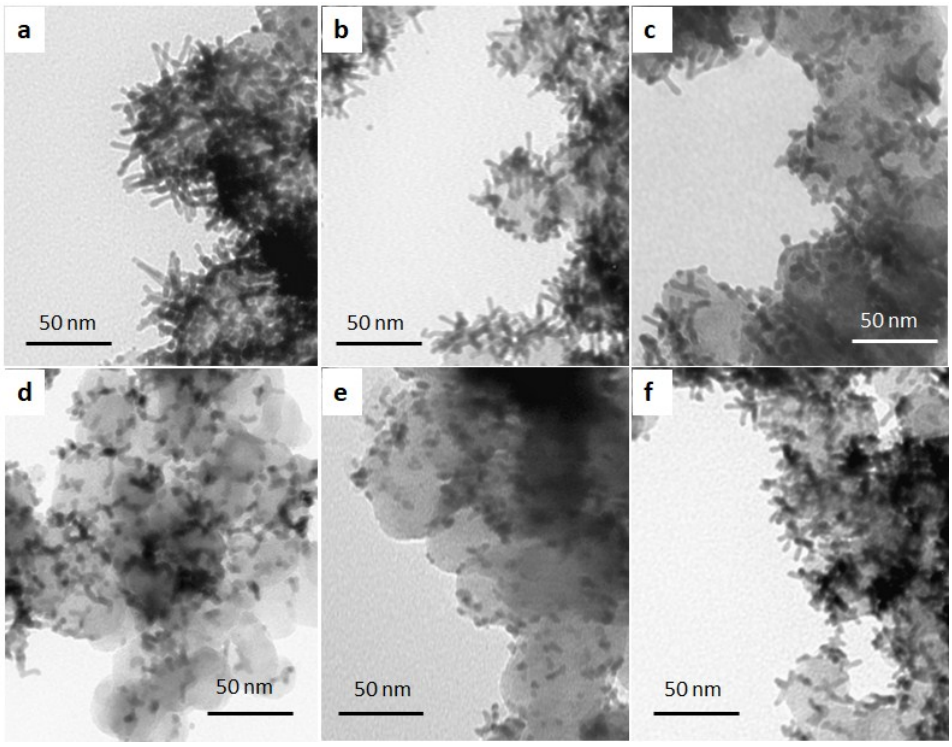

Fig. S2 TEM images of the AgPt NR/C catalysts with different atomic ratios of Ag to Pt: **a)** Pt NR/C, **b)** Ag_1Pt_4 NR/C, **c)** Ag_1Pt_2 NR/C, **d)** Ag_1Pt_1 NR/C, **e)** Ag_2Pt_1 NR/C and **f)** Ag_2Pt_1 NR/C –ii (the concentration of metal precursors were doubled toward the formic acid).

Table S1 The meatal residue generated by TGA and the corresponding metal content measured by ICP-MS and SEM-EDX.

Catalysts	TGA (metal loading / wt%)	ICP-MS / wt%		ICP-MS / at%		EDX / at%	
		Ag	Pt	Ag	Pt	Ag	Pt
Pt NR/C	58.20	0	100	0	100	0	100
Ag_1Pt_4 NR/C	61.20	11.53	88.47	19.07	80.93	22.29	77.71
Ag_1Pt_2 NR/C	62.04	21.16	78.84	32.67	67.32	39.95	60.05
Ag_1Pt_1 NR/C	60.98	32.23	67.77	46.23	53.77	55.54	44.46
Ag_2Pt_1 NR/C	63.22	52.82	47.18	66.94	33.06	70.47	29.53

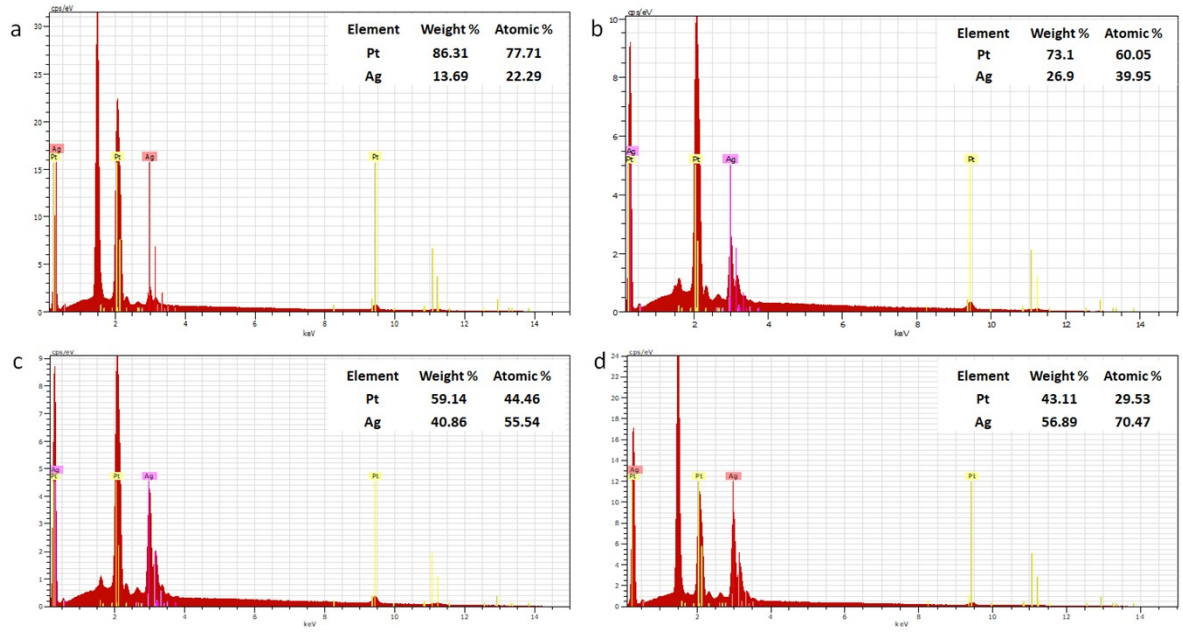

Fig. S3 EDX spectrum of **a)** Ag_1Pt_4 NR/C, **b)** Ag_1Pt_2 NR/C, **c)** Ag_1Pt_1 NR/C and **d)** Ag_2Pt_1 NR/C.

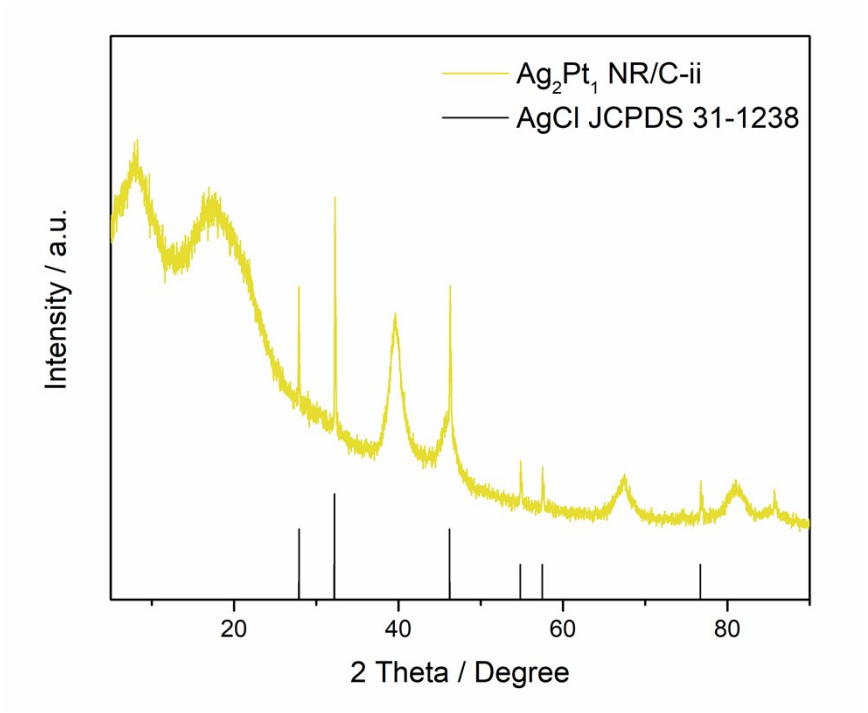

Fig. S4 XRD pattern of Ag_2Pt_1 NR/C -ii, produced by using double Ag and Pt precursor concentration with the same amount of formic acid, resulting in the formation of enormous amount AgCl.

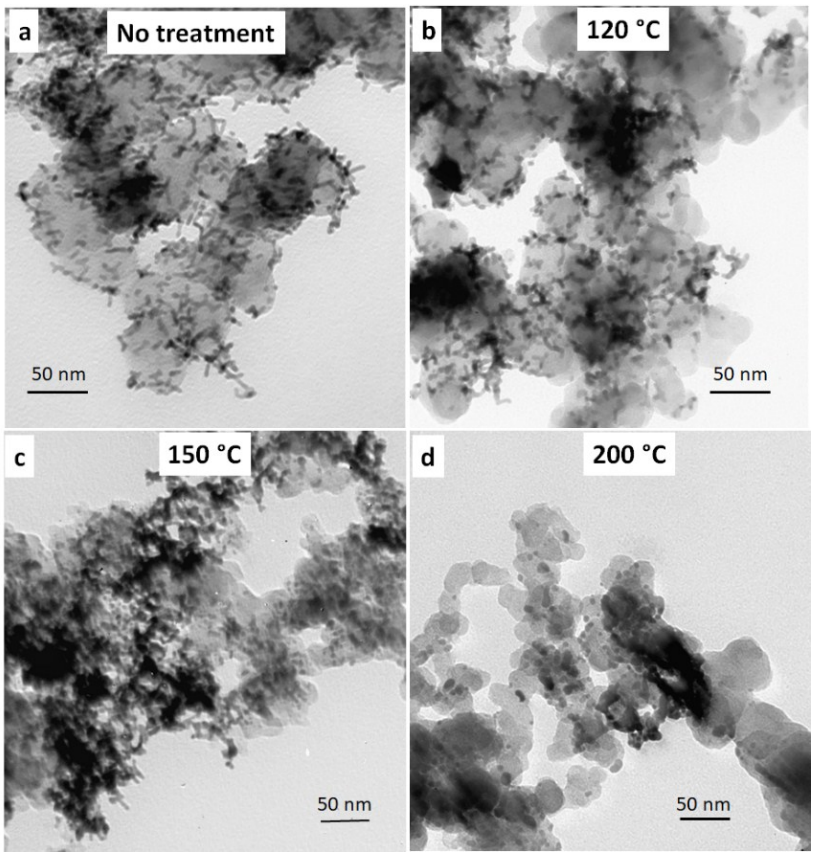

Fig. S5 TEM images of Ag_1Pt_1 NR/C heat-treated at different temperatures under 4% H_2/Ar flow for 2 hours.

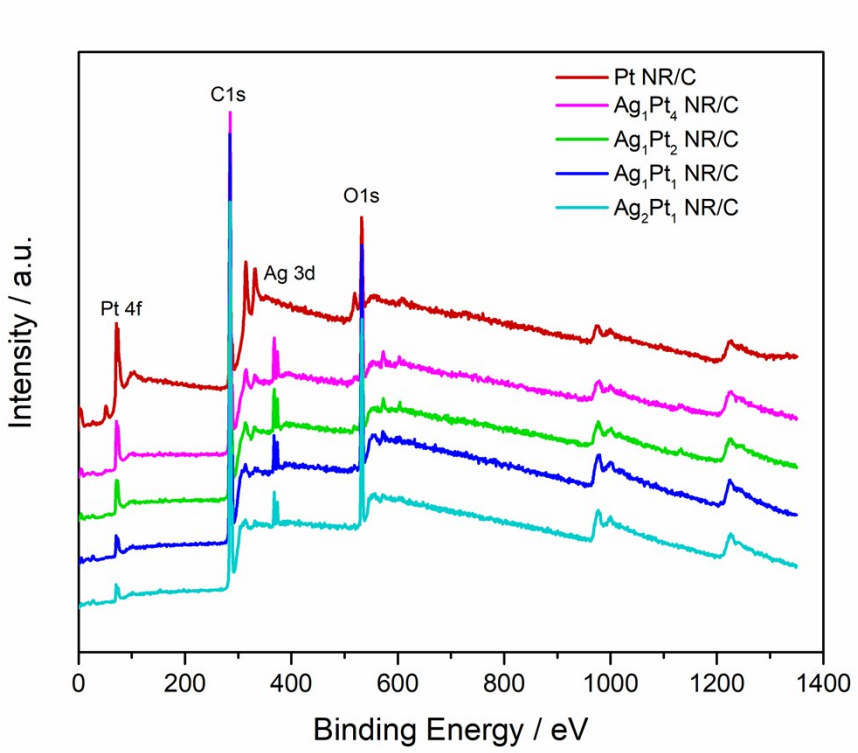

Fig. S6 XPS survey for the Pt NR/C and AgPt NR/C catalysts with the varied Ag and Pt ratios.

Table S2 The composition of Pt and Ag oxidation states obtained from Pt 4f and Ag 3d XPS region

	Pt 4f / %			Ag 3d / %	
Catalysts	Pt^0	Pt^{2+}	Pt^{4+}	Ag^0	Ag^+
Pt NR/C	100	0	0	0	0
Ag_1Pt_4 NR/C	96.23	2.19	1.58	100	0
Ag_1Pt_2 NR/C	94.48	2.82	2.7	100	0
Ag_1Pt_1 NR/C	94.08	3.50	2.42	100	0
Ag_2Pt_1 NR/C	94.03	3.08	2.86	97.99	2.01

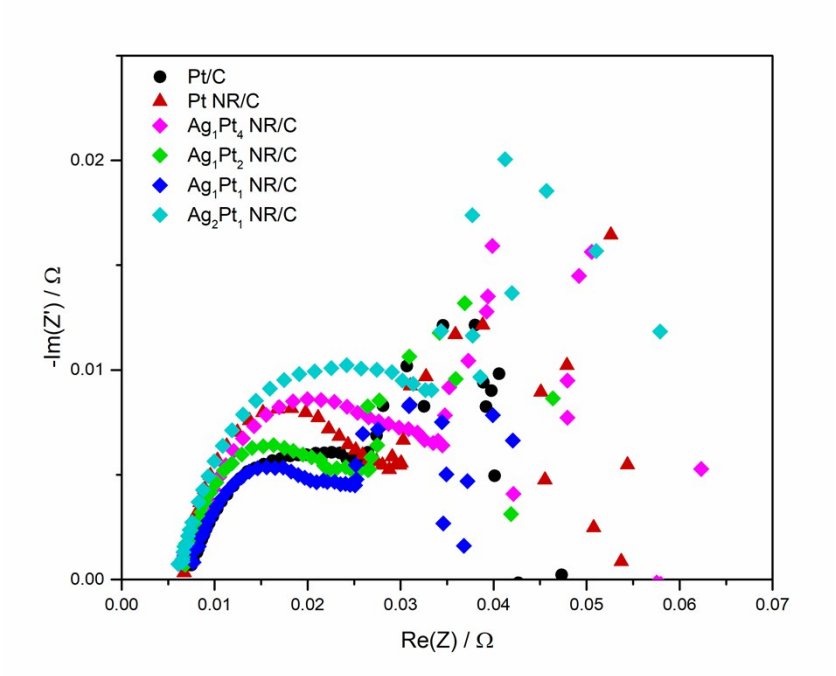

Fig. S7 EIS measured at 0.5 V with an amplitude of 10 mV in the frequency range 10k–0.1 Hz.

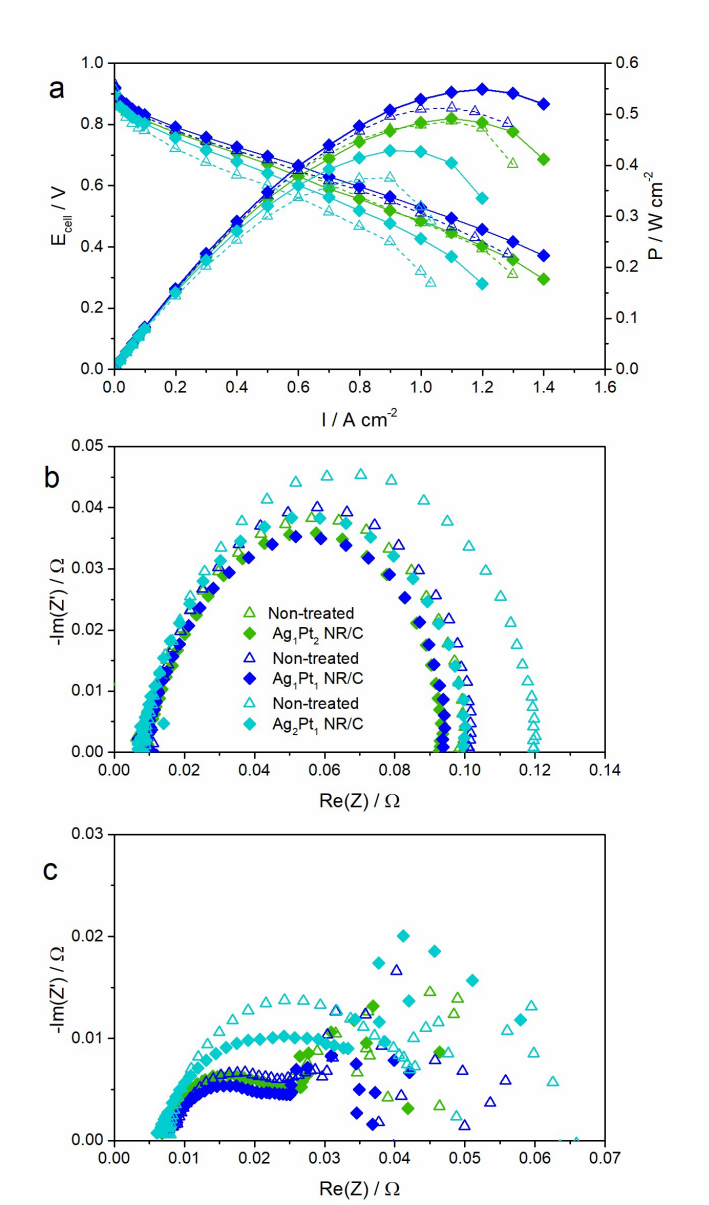

Fig. S8 MEA testing results of the as-made AgPt NR/C catalysts in comparison to the same catalysts prior heat treatment: **a)** polarization and power density curves, and **b)** EIS plots recorded at 0.03 A cm^{-2} with an amplitude of 72 mA, **c)** 0.5 V with an amplitude of 10 mV in the frequency range 10k–0.1 Hz. (The measurements were recorded at a cell temperature of 80 °C and fully humidified H_2/air with a pressure of 2.5/2.3 bar and the stoichiometry of 1.3/1.5, respectively).

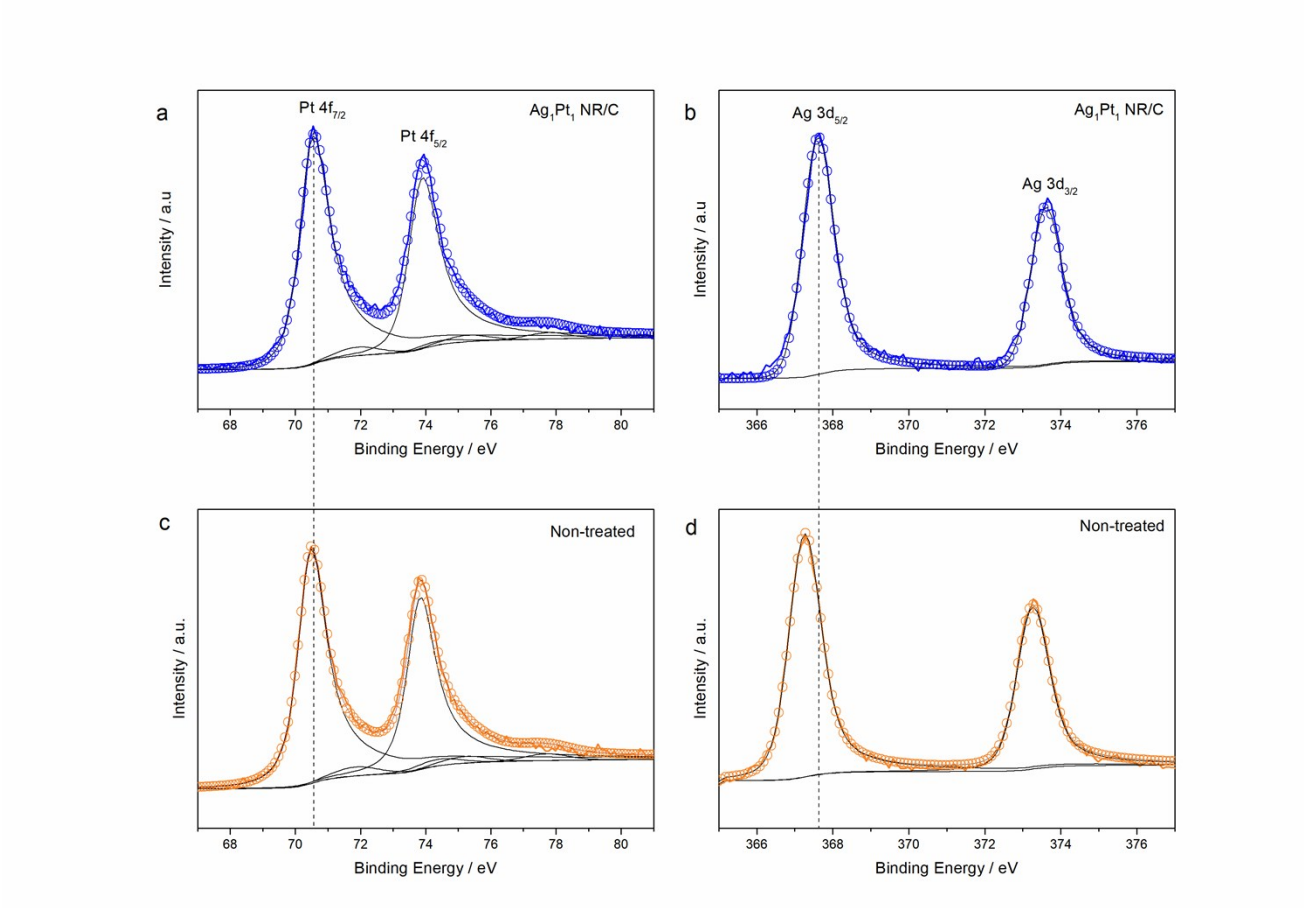

Fig. S9 XPS spectra of high-resolution Pt 4f and Ag 3d region of **a-b)** Ag_1Pt_1 NR/C and **c-d)** non-heat treatment Ag_1Pt_1 NR/C catalysts.

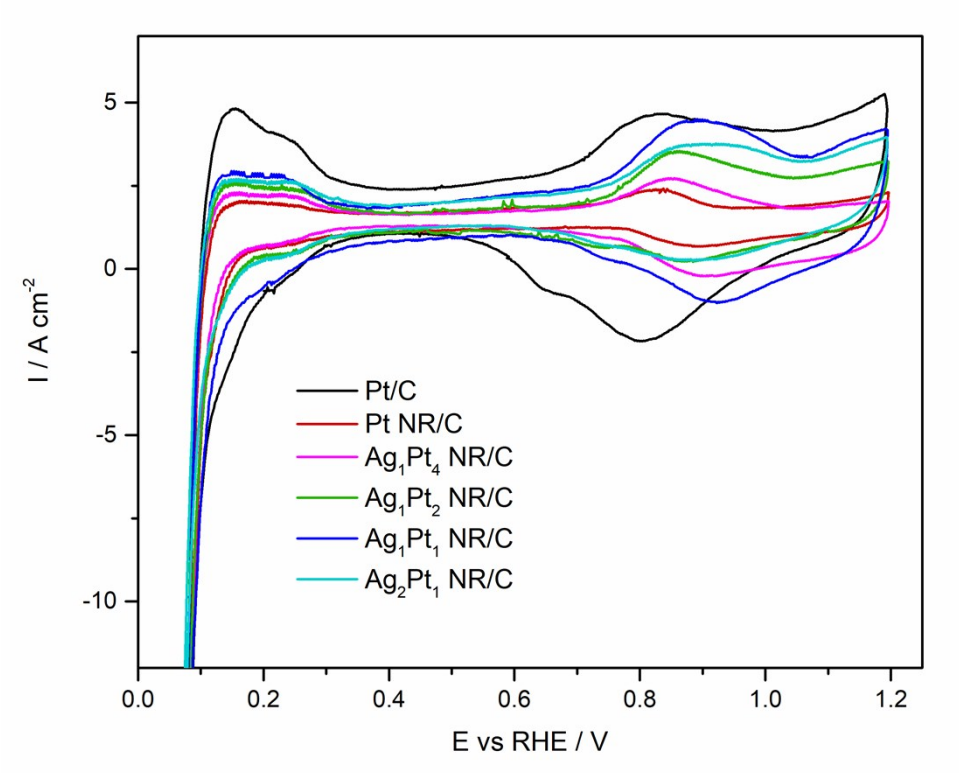

Fig. S10 Cathode CVs of the Pt/C, Pt NR/C and AgPt NR/C catalysts with different Ag and Pt ratios recorded between 0.05-1.2 V with a scan rate of 20 mV s^{-1} (the cathode was fully saturated in N_2).

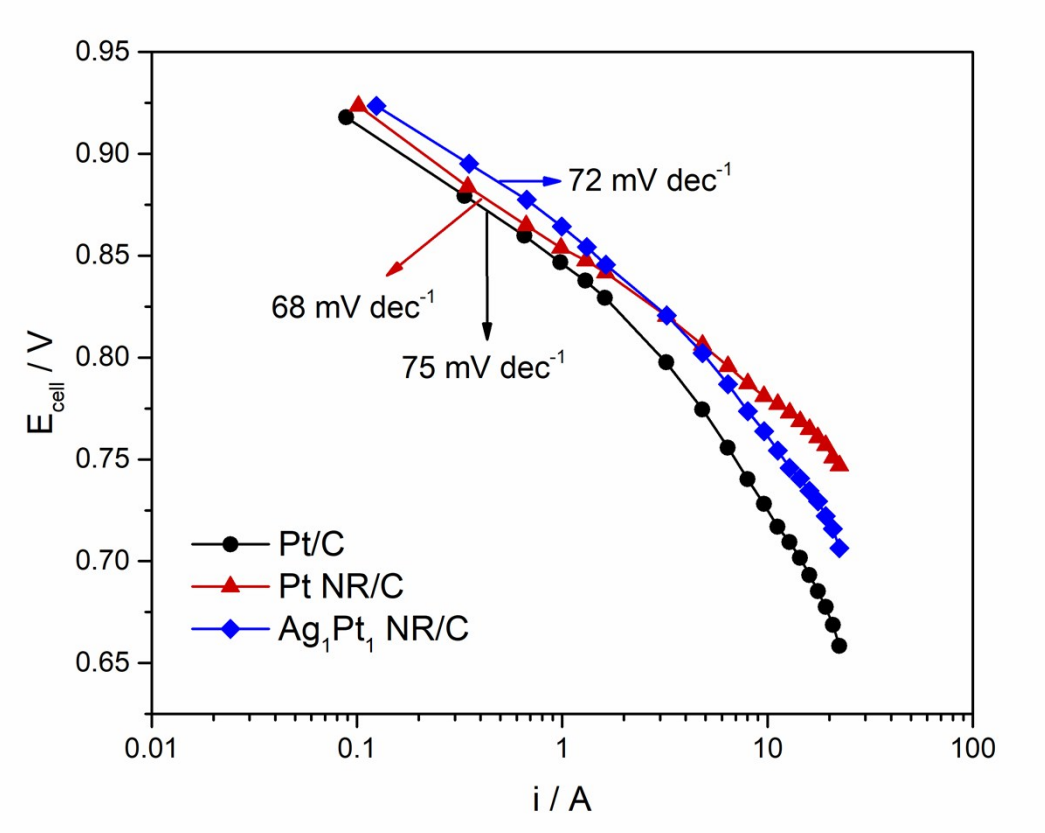

Fig. S11 Tafel slopes based on the polarization curves obtained under H_2/O_2 testing at a pressure of 1.5/1.5 bar with stoichiometry ratios of 2/9.5, respectively. The measurements were recorded at a cell temperature of 80 °C and fully humidified gases. The slope were determined based on the first 5 points at the high potential region.

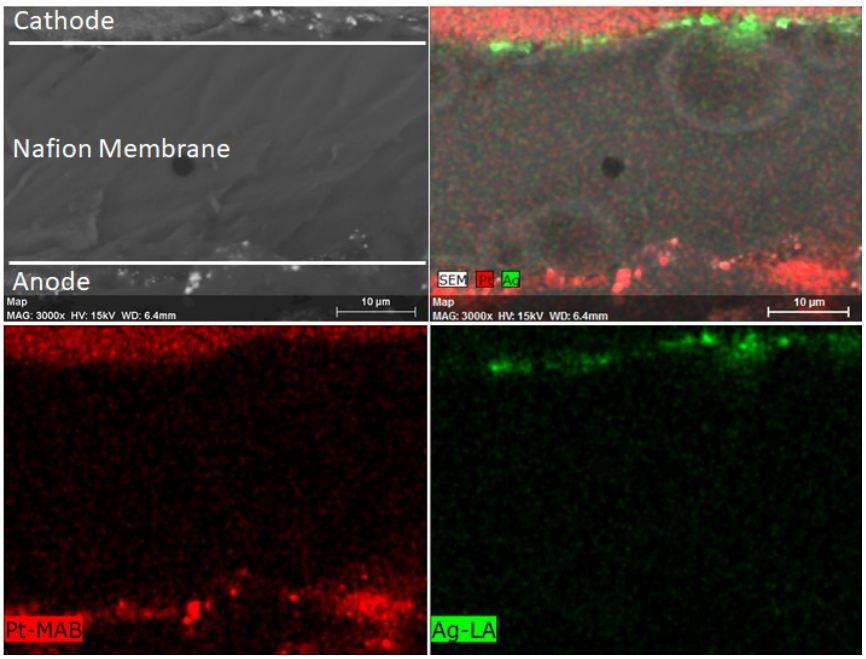

Fig S12 Cross-sectional SEM-EDX mapping of Ag_1Pt_1 NR/C after the ADT