

Supporting Information

A trifunctional N-doped activated carbon-ceria-shell derived from covalent porphyrin polymers for promoting Pt-activity in fuel cell's cathode performance

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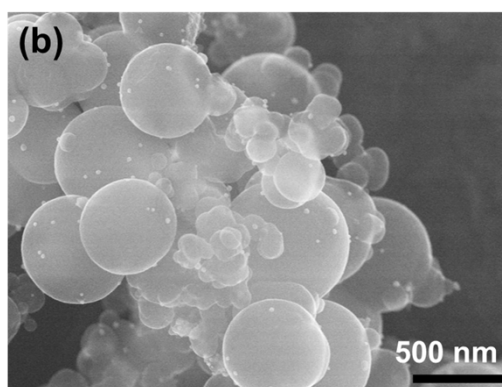
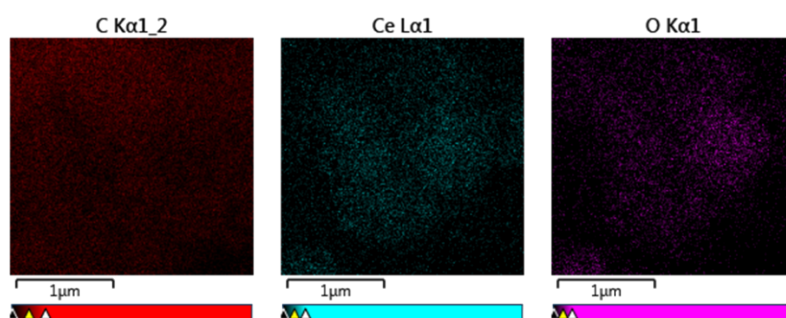
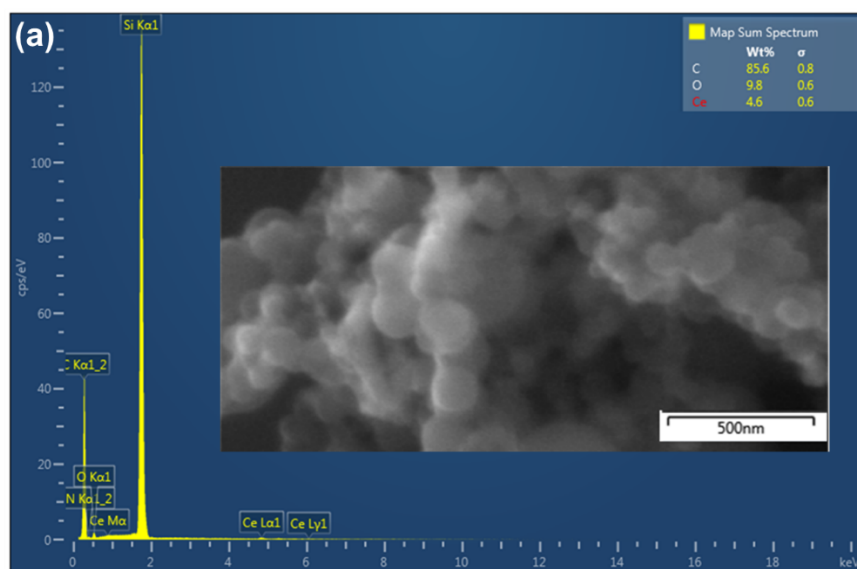


Fig. S1. (a) SEM-EDX and elemental mapping of C@CeO₂; (b) SEM of CeO₂@POP

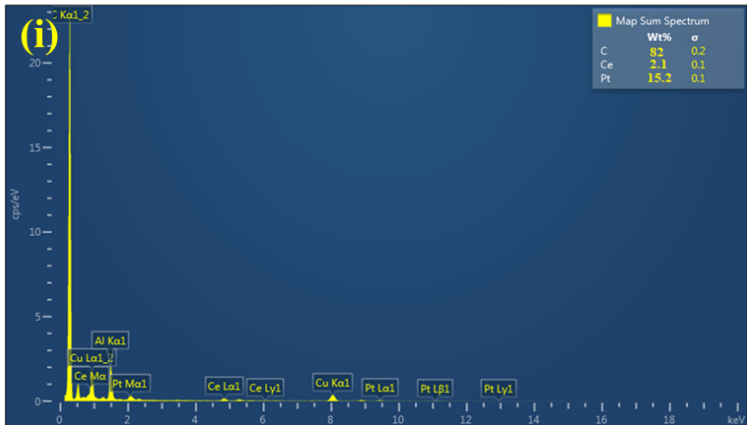
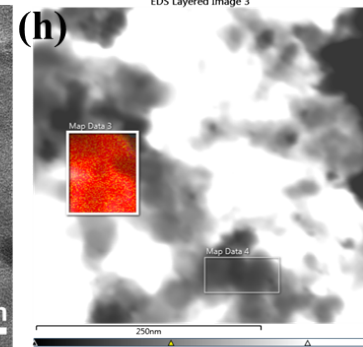
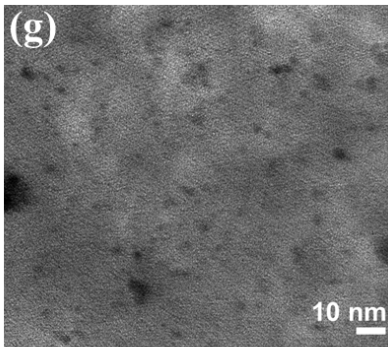
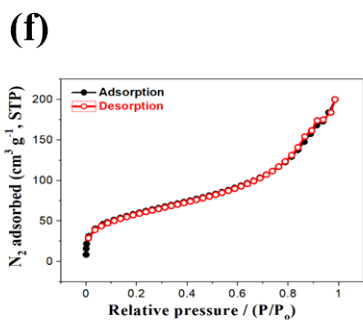
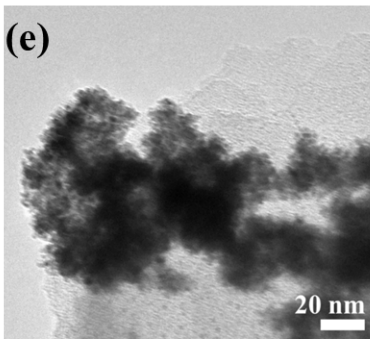
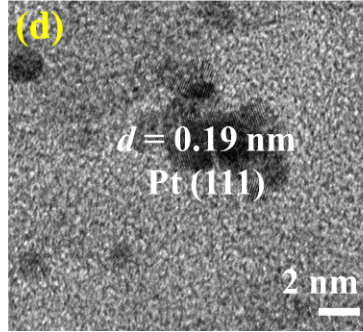
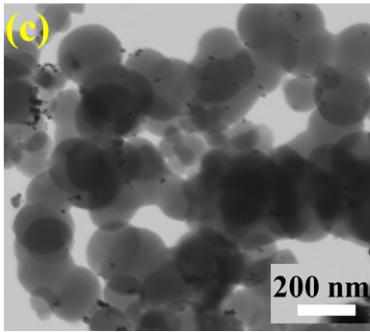
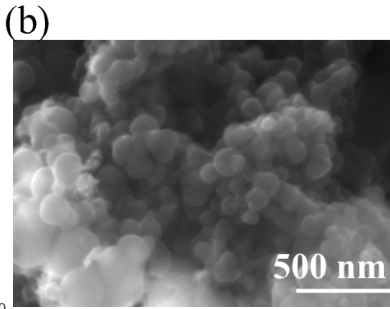
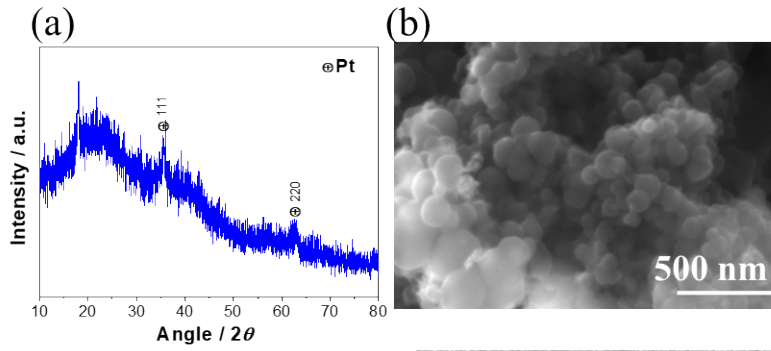


Fig. S2. (a) PXRD, (b) FESEM, (c) TEM and (d) HRTEM images of Pt/KC (Pt on templated activated carbon support); (e) TEM image of Pt/CeO₂; (f) N₂ sorption isotherm of Pt/CeO₂; (g) HRTEM of Pt/KC@CeO₂ after the accelerated durability stress test (ADST) of 5000 cycles under N₂ saturated 0.5 M H₂SO₄ solution at 50 mV s⁻¹ scanning rate with 25 μg cm⁻² of loading; (h,i) FESEM and EDX analysis after 5000 ADST cycles of Pt/KC@CeO₂

Table S1. Peak quantification of deconvoluted C1s, O1s, N1s, Pt4f and Ce3d of Pt-KC@CeO₂

C1s (Atomic conc.%)	-C=C (285.6 eV)	53.3
	-C-N (285.7 eV)	2.9
	-CO ₃ (290.6 eV)	5.58
	-C-O (287.7 eV)	11.42
	-C=O (288.8 eV)	2.77
	-O-C=O (290.7 eV)	6.26
O1s (Atomic conc.%)	O-M (530.9 eV)	1.45
	C=O/C-O (532.8 eV)	6.2
	C-O (535.8 eV)	1.25
N1s (Atomic conc.%)	Pyridinic N-Metal (397.8 eV)	1.32
	Pyrrolic N (400 eV)	1.75
	Graphitic N (402.5 eV)	0.24
	Oxidized NO ₂ (404.2 eV)	0.1
	-NO ₃ (406 eV)	0.09
Pt4f ^a (Atomic conc.%)	Pt(0) (71.4 eV)	1.07
	Pt(II) (72.4 eV)	0.1
	Pt(IV) (76.9 eV)	0.04
Ce3d ^b (Atomic conc.%)	Ce(0) (878.5 eV)	0.36
	Ce(II) (881.08 eV)	0.5
	Ce(II) (882.3 eV)	0.16
	Ce(III) (892.3 eV)	0.1
	Ce(IV) (895.4 eV)	0.15

^a16.5 wt% based on ICP analysis

^b1.9 wt% from ICP analysis

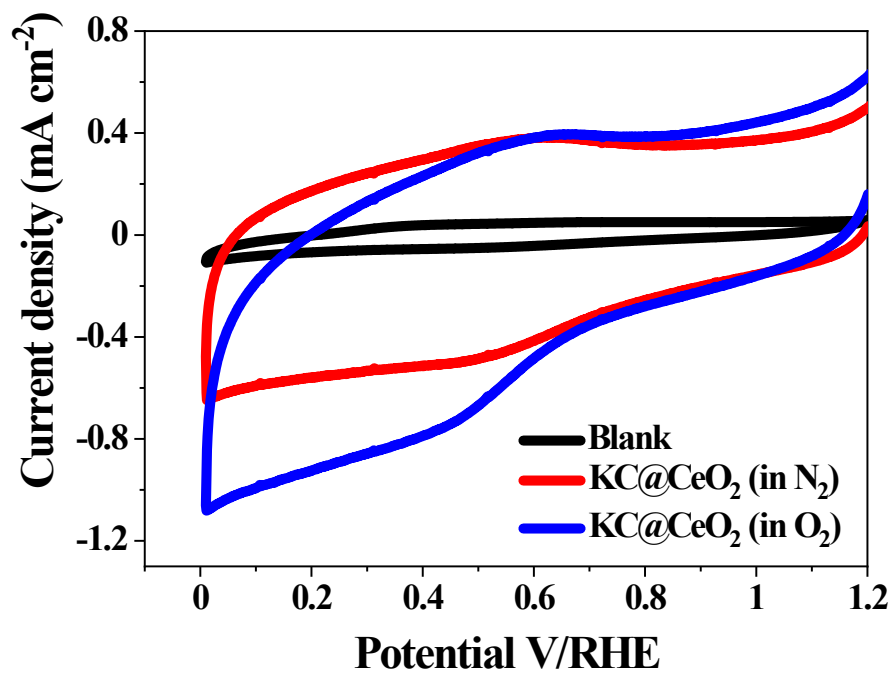


Fig. S3. CV of the activated carbon support, KC@CeO₂ (loading 100 $\mu\text{g cm}^{-2}$) in N₂ (red) and oxygen (blue) in 0.5 M H₂SO₄ at a scan rate of 50 mV s⁻¹ at 25 °C

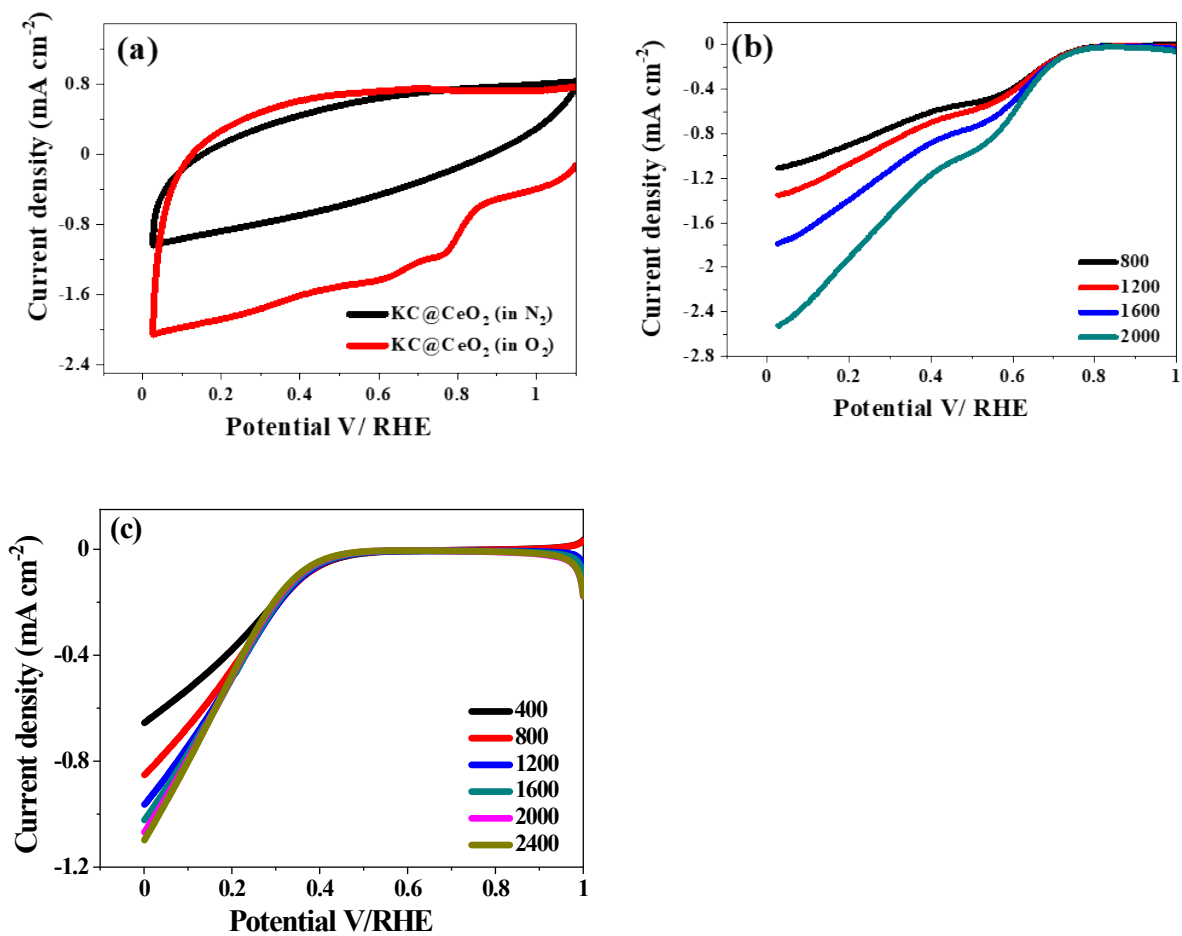


Fig. S4. (a) CV and (b) LSV on disk current at different RPM speeds of activated carbon support KC@CeO₂ (non-platinized) in 0.1 M KOH in N₂ (black) and O₂ (red); (c) LSV of the Pt-free nitrogen-doped activated carbon support, KC@CeO₂ at 1600 rpm at a scan rate of 5 mV sec⁻¹ in O₂ saturated 0.5 M H₂SO₄ electrolyte

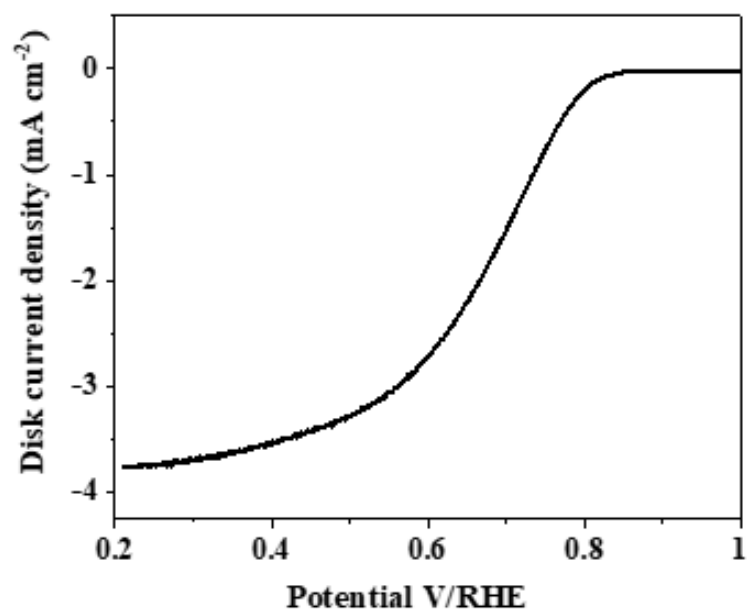


Fig. S5. ORR polarization curve of Pt/KC@CeO₂-1 with 15.5 wt% Pt (loading of 25 μg cm⁻²) at 1600 rpm at a scan rate of 5 mV s⁻¹, at 25 °C

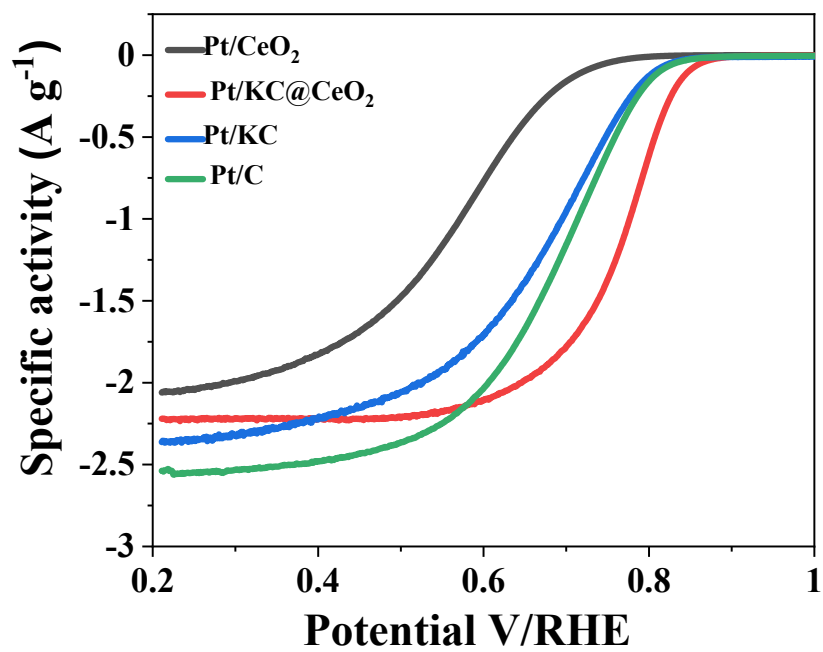


Fig. S6. Specific current plot of Pt-ceria composites (loading of 25 $\mu\text{g cm}^{-2}$ at 25 $^{\circ}\text{C}$) at 1600 rpm at a scan rate of 5 mV s^{-1} in an oxygen saturated 0.5M H_2SO_4 as electrolyte

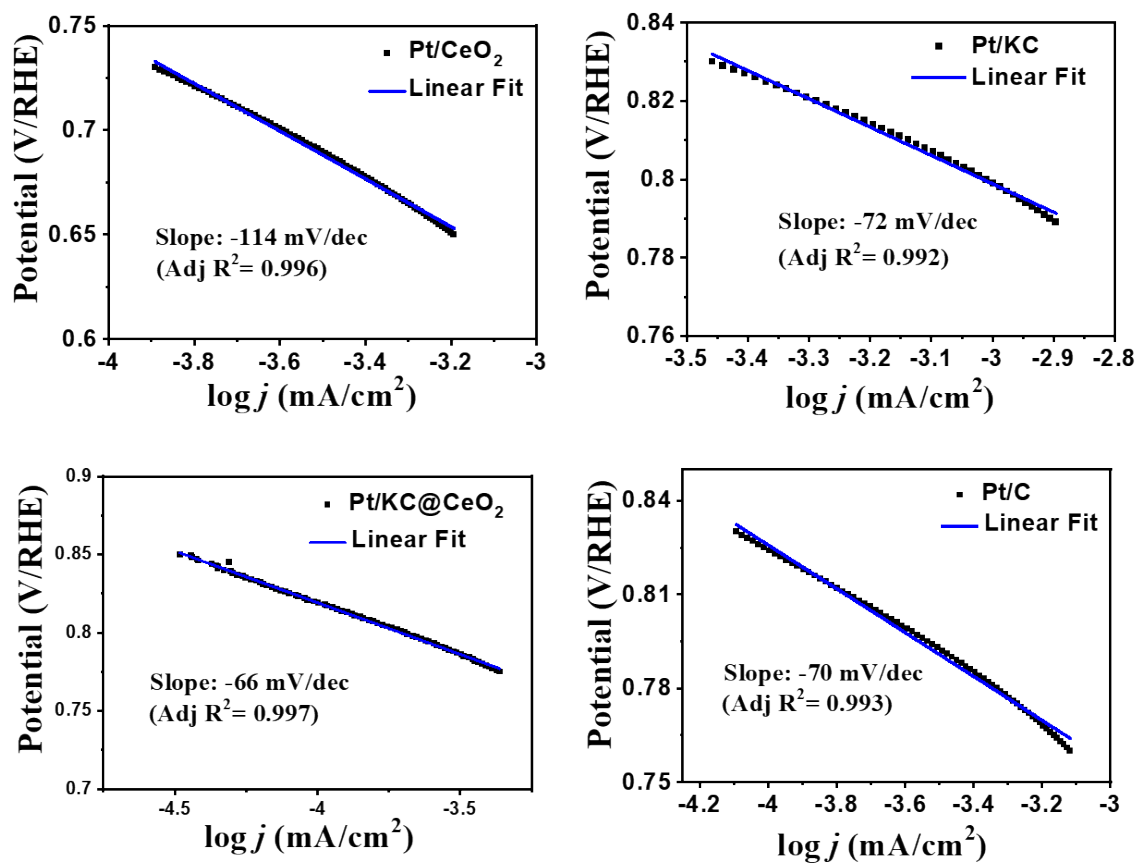


Fig. S7. Tafel plot of Pt-CeO₂, Pt/KC, Pt/KC@CeO₂ and Pt/C as obtained from the kinetic current of ORR polarization curve (Figure 7a main text) for a 0.5 M oxygen saturated H₂SO₄ solution at 1600 rpm at a scan rate of 5 mV s⁻¹, at 25 °C

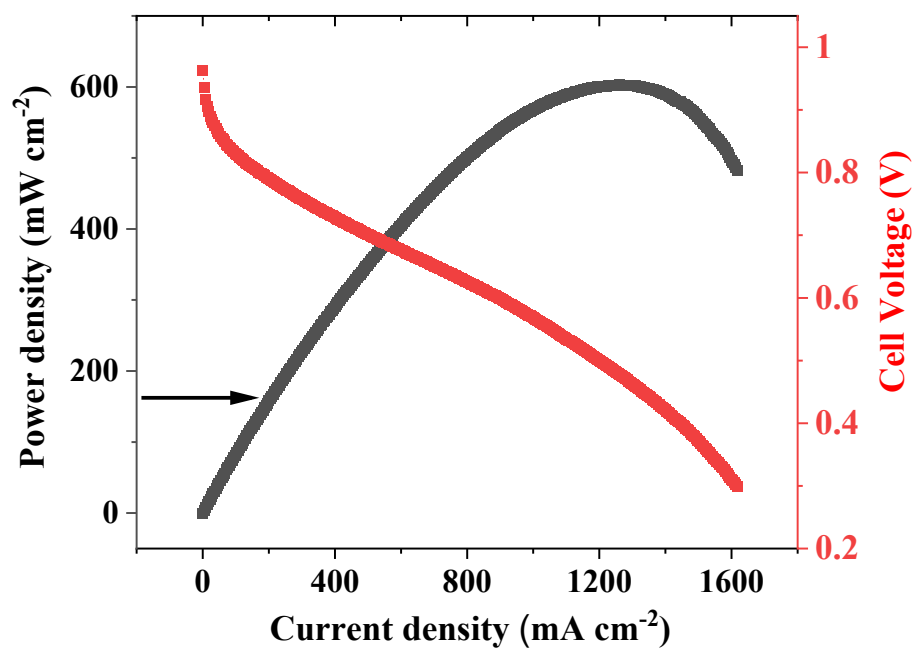


Fig. S8. Polarization curves of PEMFC performance of single-cell fabricated with Pt/KC@CeO₂-1 under H₂/O₂ with cathode loading of 0.5 mg cm⁻² and anode loading of 0.5 mg cm⁻² Pt/C under flow conditions of H₂ 0.2 L min⁻¹, O₂ 0.2 L min⁻¹; 100 RH % and 15 psi backpressure at 65 °C