

Electronic Supplementary Material

Calculation of electrochemical measurements:

For CV collection on RDE, the working electrode was scanned at a rate of 20 mV/s. The charge of PdO peak Q was determined in the potential range of 0.6–0.9 V from the negative-going scan. The Pd electrochemical surface area (ECSA) was given by the following equation:

$$\text{ECSA} = \frac{Q}{0.405 \times \text{Pd}} \quad (\text{S1})$$

The Pt ECSA was given by the following equation:

$$\text{ECSA}(\text{m}^2 \cdot \text{g}_{\text{Pt}}^{-1}) = \frac{Q_{\text{H-adsorption}}(\text{C})}{210 \mu\text{C} \cdot \text{cm}_{\text{Pt}}^{-2} (\text{mg}_{\text{Pt}} \cdot \text{cm}^{-2}) \cdot \text{Ag}(\text{cm}^2)} \times 10^5 \quad (\text{S2})$$

The kinetic current @ 0.9 V was obtained from a scan at 1600 RPM by Eq. S3:

$$I_k = \frac{I_{\text{lim}}(\text{A}) \times I(\text{A})}{(I_{\text{lim}} - I)} \quad (\text{S3})$$

where I_k was the kinetic current and I_{lim} was limiting current and I was the measured current at 0.9 V. The I_k was normalized by the noble metal loading on the disk electrode to calculate the mass activity. And the specific activities were estimated by dividing the mass activity by the ECSA.

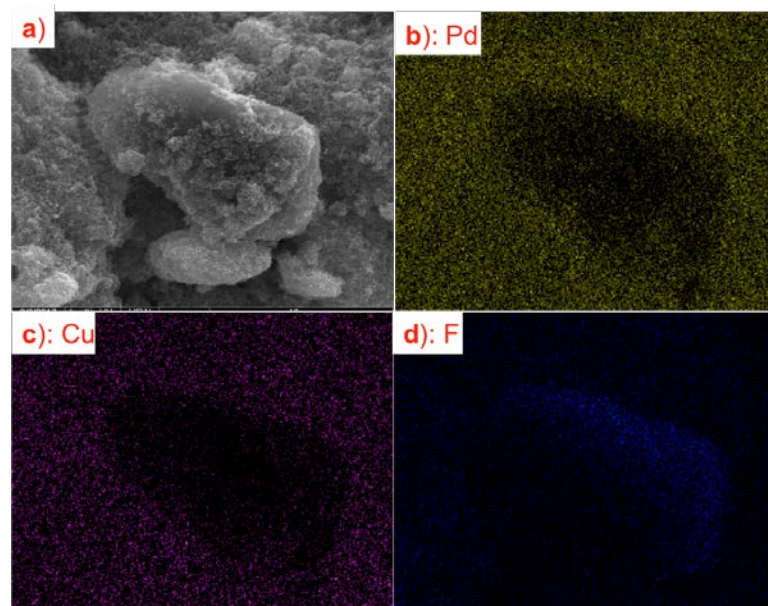


Figure S1. (a) SEM image of surface of GDE; (b) (c) (d) Pd, Cu and F elemental mapping of surface of GDE

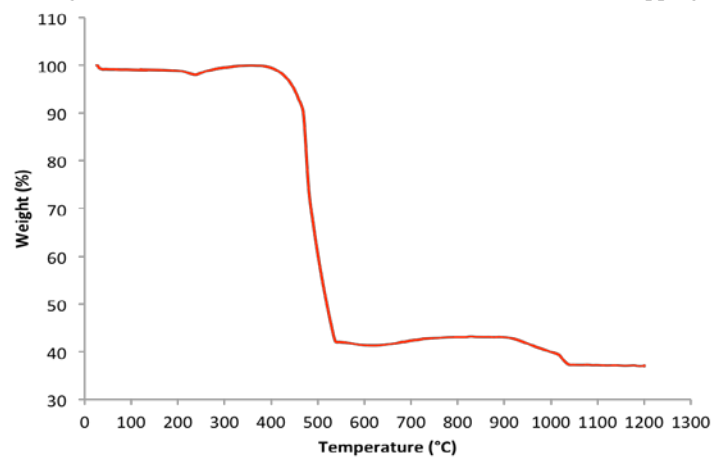


Figure S2. Thermo gravimetric analysis (TGA) of Pd-Cu/Vulcan. The O₂ flow rate was kept at 20 mL/min

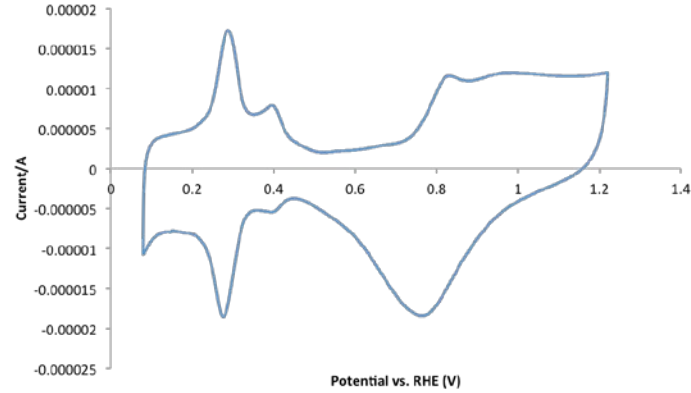


Figure S3. CV of Pt/C in N₂ purged 0.1M KOH

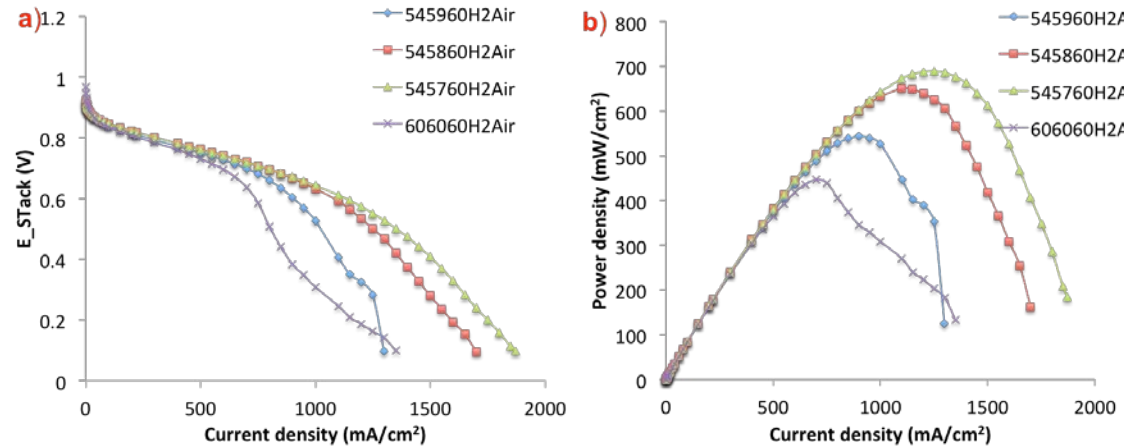


Figure S4. AEMFC performance at cell temperature of 60°C, cathode humidifier temperature of 54°C. The temperature of anode humidifier was changed from 59°C to 57°C to obtain best cell condition. The temperatures are cathode/anode/cell in order. The anode Pt-Ru loading was kept at 0.60 ± 0.01 mg/cm², the cathode Pd loading was kept at 0.6 ± 0.01 mg/cm². H₂ and air was fed on anode and cathode with flowing rate 0.2 L/min and 0.7 L/min, respectively.

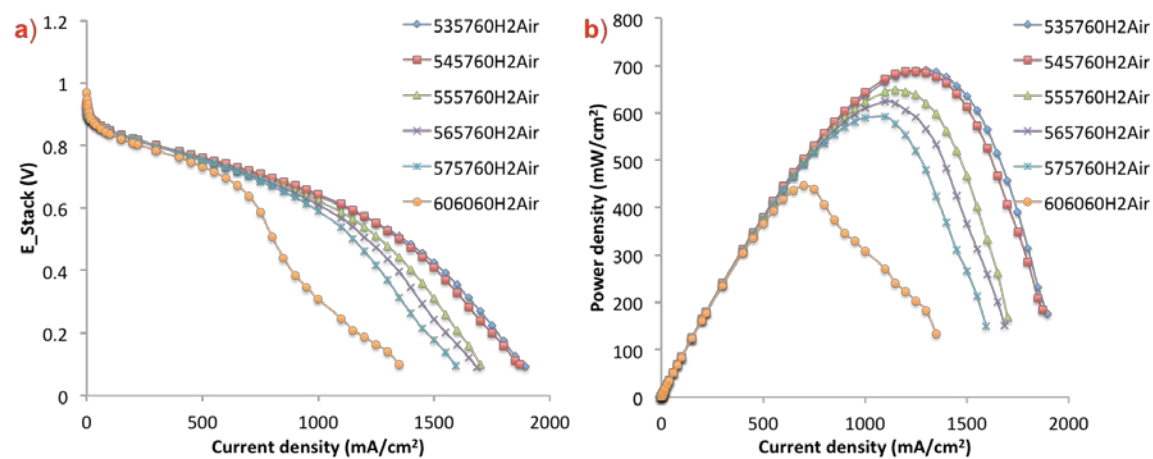


Figure S5. AEMFC performance at cell temperature of 60°C, anode humidifier temperature of 57°C. The cathode humidifier was changed from 53°C to 57°C to obtain best cell condition. The temperatures are cathode/anode/cell in order. The anode Pt-Ru loading was kept at $0.60 \pm 0.03 \text{ mg}/\text{cm}^2$, the cathode Pd loading was kept at $0.60 \pm 0.03 \text{ mg}/\text{cm}^2$. H_2 and air was fed on anode and cathode with flowing rate 0.2 L/min and 0.7 L/min, respectively

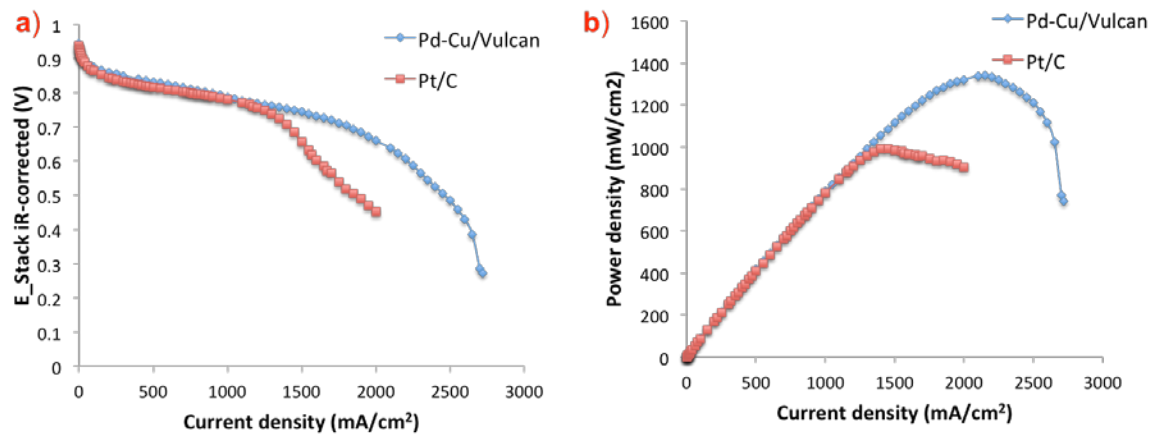


Figure S6. The iR corrected data. (a) polarization curves; (b) power densities

Table S1. Comparison of AEMFC performance in this work with the literature

Membrane type	Pt/Pd/PtRu catalyst loading (mg/cm ²)		GDL type	Ionomer type	Current density (A/cm ²) at 0.7 V	Peak power density/(W/cm ²)	Total peak power per metal loading/(W/mg)	Operating condition			
	Cathode	Anode						Back pressure (Kpa)	T _{cell} /°C	T (Ca/An)	Gas type (An/Ca)
ETFE-g-VBCTMA [this work]	0.6	0.6	Toray 60	ETFE-g-VBCTM	1.3 (O ₂)/0.7 (Air)	1.1 (O ₂)/0.7 (Air)	1.83(O ₂)/1.17(Air)	0/0	60	54/57	H ₂ /O ₂ ; H ₂ /Air
A 901 [1]	0.4	0.4	Toray 60	AS-4	0.6 (O ₂)	0.737	1.84	250/250	80	85/85	H ₂ /O ₂
A 901 [2]	0.5	0.5	Toray 60	AS-X	0.3 (O ₂)/0.25(Air)	0.45 (O ₂)/0.34 (Air)	0.9 (O ₂)/0.68 (Air)	—	50	49/49	H ₂ /O ₂ ; H ₂ /Air
HMT-PMBI [3]	0.4	0.4	SGL 24BC	HMT-PMBI	0.3 (O ₂)	0.37 (O ₂)	0.925	0/0	60	60/60	H ₂ /O ₂
aQAPS-S ₈ [4]	0.4	0.4	AvCarb GDS3250	aQAPS-S ₈	1 (O ₂)	1 (O ₂)	2.5	101/101	60	60/60	H ₂ /O ₂
T25NC6NC5N [5]	0.4	0.4	CeTech W1S1005	T25NC6N C5N	0.4 (O ₂)	0.364 (O ₂)	0.91	101/101	60	60/60	H ₂ /O ₂
Cellera [6]	3.0 (Ag)	0.3	CeTech carbon paper	—	0.4 (Air)	0.5	1.67	100/300	73	73/25	H ₂ /Air
LDPE-g-VBC [7]	0.4	0.4	FFCCT	LDPE-g-VBC	0.75 (O ₂)	0.823	2.0	0/0	60	60/60	H ₂ /O ₂
ETFE-g-VBCTMA [8]	0.4	0.4	AvCarb GDS3250	aQAPS-S ₁₄	0.7(O ₂)	0.98	2.45	100/100	60	60/60	H ₂ /O ₂

Notes: —: Not known.

References

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