



## Supporting Information

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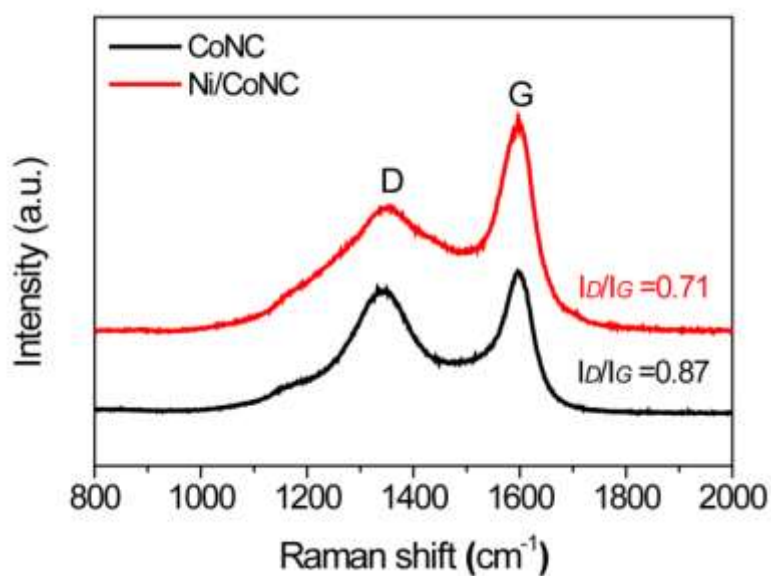
Metal–Organic-Framework-Derived Dual Metal- and Nitrogen-Doped Carbon as Efficient and Robust Oxygen Reduction Reaction Catalysts for Microbial Fuel Cells

*Haolin Tang,\* Shichang Cai, Shilei Xie, Zhengbang Wang, Yexiang Tong, Mu Pan, and Xihong Lu\**

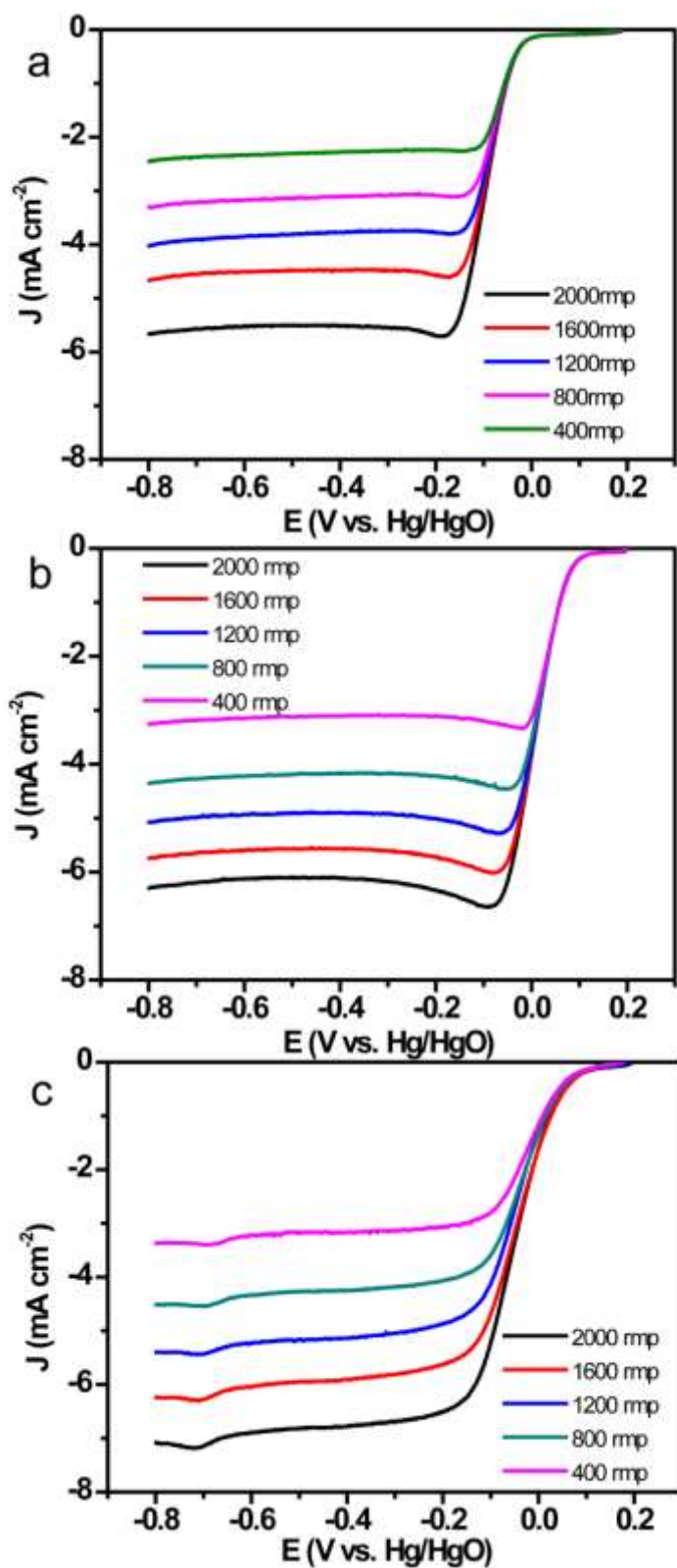
## Supporting Information

**Metal Organic Framework Derived Dual Metal and Nitrogen doped Carbon as Efficient and Robust Oxygen Reduction Reaction Catalysts for Microbial Fuel Cells**

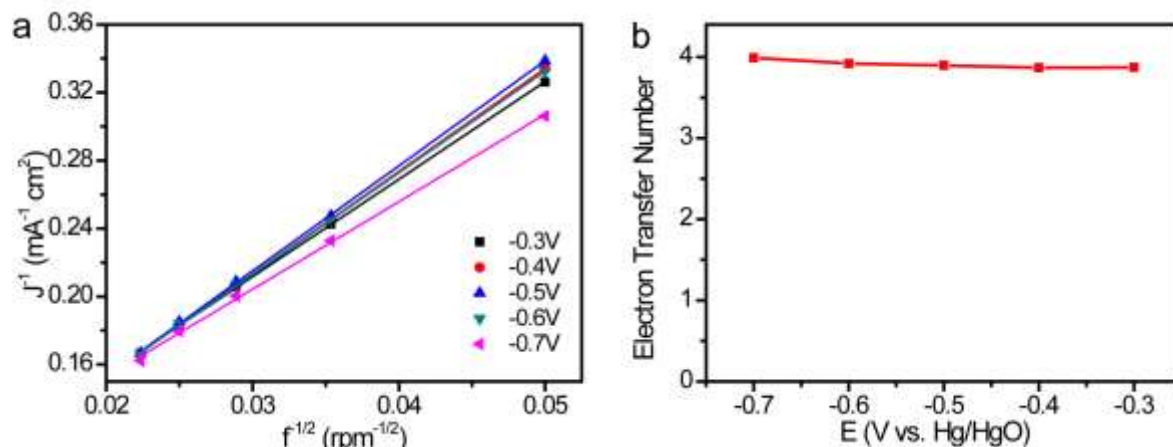
Haolin Tang,<sup>a\*</sup> Shichang Cai,<sup>a</sup> Shilei Xie,<sup>b</sup> Zhengbang Wang,<sup>c</sup> Yexiang Tong,<sup>b</sup> Mu Pan,<sup>a</sup> and Xihong Lu<sup>b\*</sup>



**Figure S1.** Raman spectra of the CoNC and Ni/CoNC catalysts.



**Figure S2.** LSV curves of (a) CoNC catalyst, (b) CoNC catalyst and (c) Pt/C catalyst in 0.1M KOH solution saturated with O<sub>2</sub> at different rotating speeds.



**Figure S3.** (a) Koutecky–Levich (K-L) plots of the Pt/C electrode at different potentials. (d) The calculated ORR electron-transfer number for the Pt/C catalyst at different potentials.

**Table S1.** Summary of ORR parameters of various electrocatalysts in alkaline media

	$J_{@-0.6V}$ (mA cm <sup>-2</sup> )	$E_{ocp}$ (V vs. Hg/HgO)	$E_{1/2}$ (V vs. Hg/HgO)	n	ref
<b>Ni/CoNC</b>	<b>6.24</b>	<b>0.070</b>	<b>-0.049</b>	<b>3.94-4</b>	<b>Our work</b>
20% Pt/C	5.74	-0.033	0.018	3.87-3.99	Our work
nitrogen-doped carbon nanofibers	6.1	0.12	-0.22	3.8	2
Fe/N doped C (1500r)	~5.1	0.20	0.03		4
N doped graphene	0.48	-0.04	-0.35		3
N-Fe/Fe <sub>3</sub> C@C	6.4	0.21	0.14	3.98	1
N-P codoped porous carbon foams	4.9	0.19	-0.11	3.7-3.8	5
PEDOT hollow spheres	2.5/1400r	~0.1	-0.27	3.11	8
S doped RGO	4.7	~0.16	-0.12	3-3.5	6
Fe-N co-doped Carbon	5.44	0.197	-0.17	3.86	7

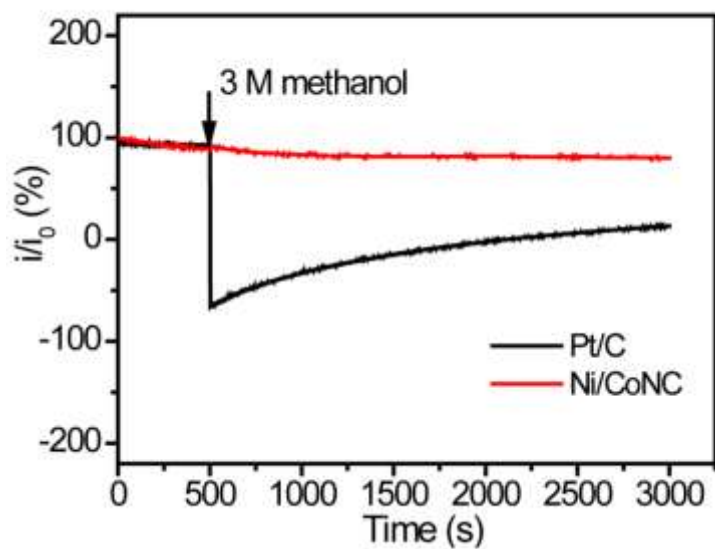
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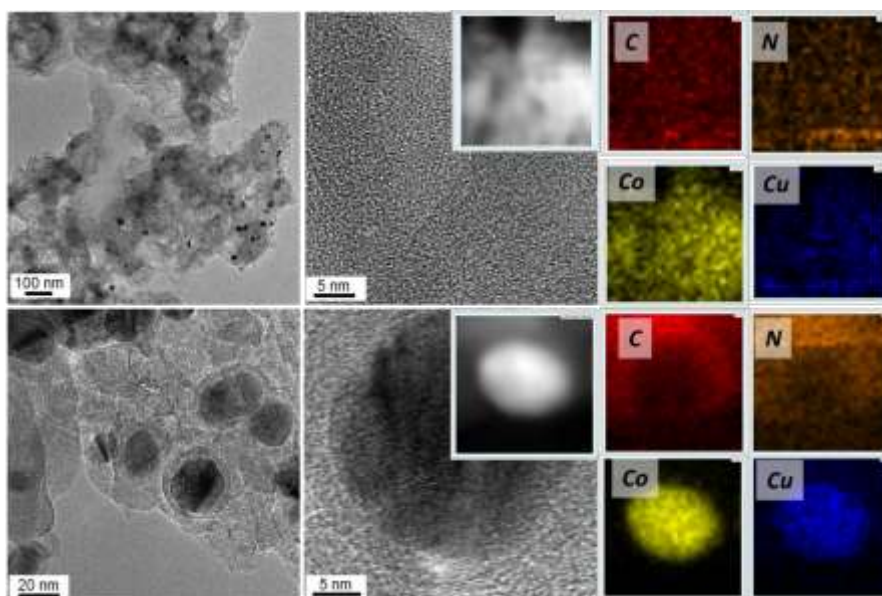
**Table S2.** Summary of ORR parameters of various electrocatalysts in neutral media

	$J_{@-0.6V}$ (mA cm <sup>-2</sup> )	$E_{ocp}$ (V vs. SCE)	n	ref	c (PBS)
<b>Ni/CoNC</b>	<b>6.66</b>	<b>0.347</b>	<b>3.92</b>	<b>Our work</b>	<b>0.01</b>
20% Pt/C	5.72	0.282	3.81	Our work	0.01
acidic/basic-N- activated carbon	7.18	0.18	4.09	9	0.1 M
Co-PDAP	~6 (1500 rpm)	0.082	3.96	10	---
Fe-C-N	6.1 (2500 rpm)	0.2	3.89	11	---
FeCo- melamine- formaldehyde resin	5.0 (1500 rpm)	0.88 (RHE)	3.96	12	0.2 M

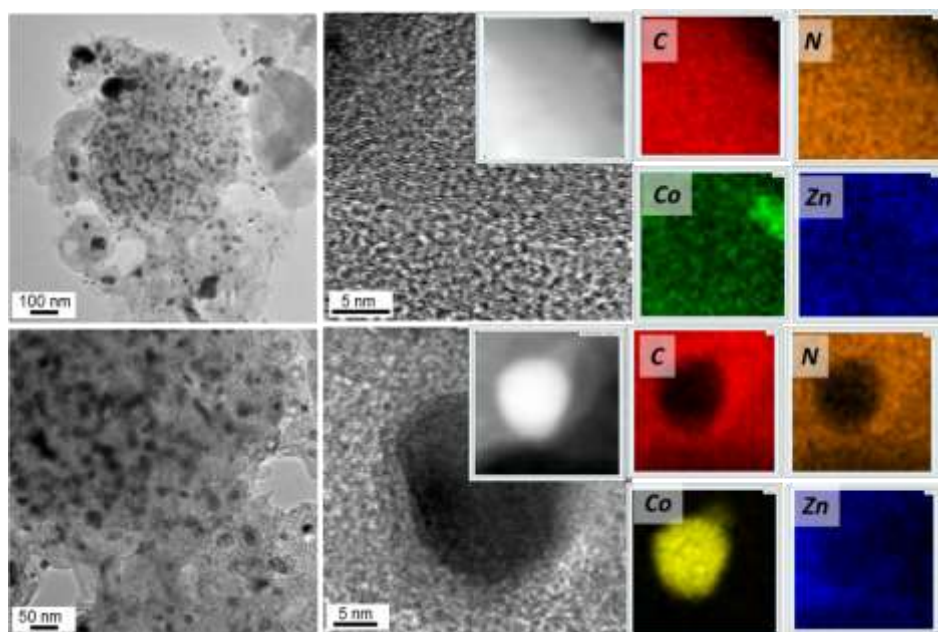
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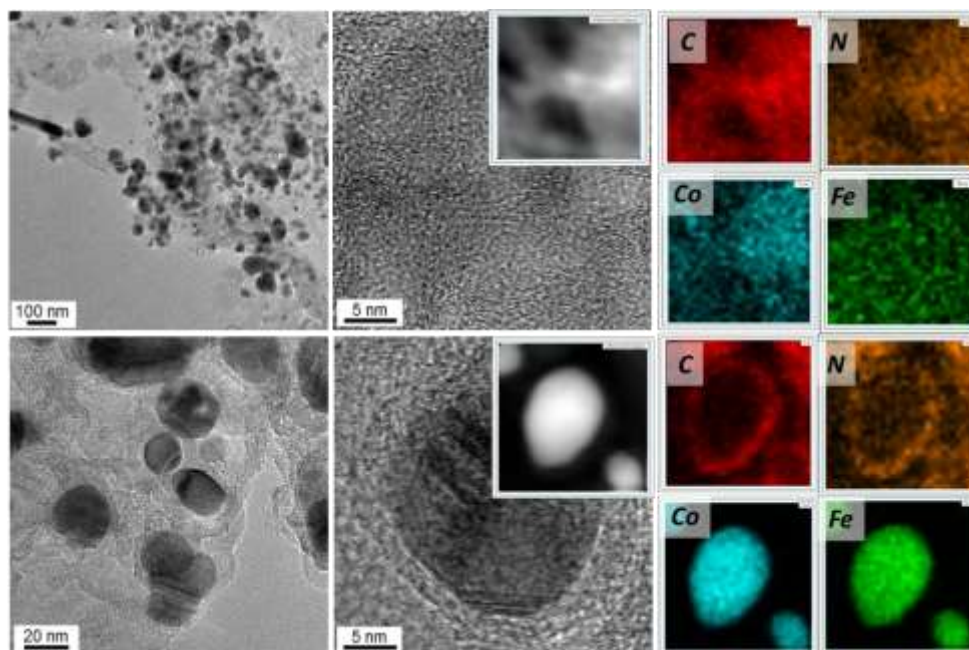
**Figure S4.** tolerance to methanol of the Ni/CoNC and Pt/C electrodes recorded at -0.3 V in  $O_2$ -saturated 10 mM PBS electrolyte with a rotation speed of 1600 rpm.



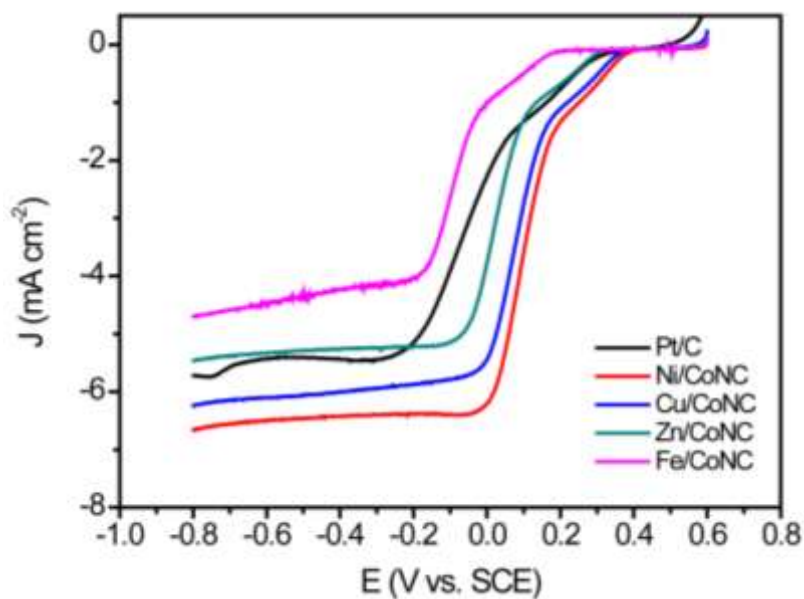
**Figure S5.** TEM, HRTEM and EELS element mapping images of the as-prepared Cu/CoNC catalyst.



**Figure S6.** TEM, HRTEM and EELS element mapping images of the as-prepared Zn/CoNC catalyst.



**Figure S7.** TEM, HRTEM and EELS element mapping images of the as-prepared Fe/CoNC catalyst.



**Figure S8.** LSV curves of the Pt/C, Zn/CoNC, Cu/CoNC, Fe/CoNC and Ni/CoNC catalysts collected in O<sub>2</sub>-saturated 0.01 M PBS at 1600 rpm

**Table S3.** The onset potential and half-wave potential of these catalysts in PBS solution

	$J_{@-0.6V}$ (mA cm <sup>-2</sup> )	$E_{ocp}$ (V vs. SCE)	$E_{1/2}$ (V vs. SCE)
Pt/C	5.72	0.282	-0.039
Fe/CoNC	4.70	0.152	-0.088
Zn/CoNC	5.46	0.275	0.034
Cu/CoNC	6.24	0.33	0.088
Ni/CoNC	6.66	0.347	0.108