**Supplementary Information:**

**A N-self-doped carbon catalyst derived from pig blood for oxygen reduction with high activity and stability**

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**Fig. S1** Schematic of the synthesis process of the CPB-Fe catalyst.

**Table S1** The content of C, N, O and different types of N contents of CPL and CPL-Fe catalysts.

**Table S2** Comparison of ORR activity of the literature reports.

**The Koutecky-Levich (K-L) equation**

**Fig. S2** ORR polarization curves for CPB, CPB-Fe and Pt/C catalysts before and after continuous potential cycles for 5000 times.



**Fig. S1** Schematic of the synthesis process of the CPB-Fe catalyst. (A) PB was diluted with an equal amount of water (In order to clearly observe the experiment, the proportion of PB and water is 1:5 in **Fig. S1**). (B) Adding FeCl3 solution. (C) Cooking and drying the mixture. (D) The precursor is carbonized in an inert atmosphere. (E) Post-treatment (PTs) including ball milling, acid leaching and the second heat treatment.

**Table S1** The content of C, N, O and different types of N contents of CPL and CPL-Fe catalysts.

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| Sample | C at% | Oat% | Nat% | Oxidized N % | Graphitic N % | Pyrrolic N % | Pyridinic N % |
| CPL | 93.22 | 3.91 | 2.87 | 14.4 | 39.4 | 16.1 | 30.1 |
| CPL-Fe | 92.92 | 4.73 | 2.35 | 12.1 | 39.2 | 13.6 | 35.1 |

**Table S2** Comparison of the onset potential (Eonset,) and half-wave potential (E1/2) of the literature.

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Catalyst** | **N sources** | **Eonset (V) /****relative to Pt/C** | **E1/2 (V) /****relative to Pt/C** | **Reference****electrode** | **Medium** | **Ref.** |
| **CPB** | Pig blood | -0.08 V /-50 mV | -0.24 V /-100 mV | SCE | 0.1 M KOHat 1600 rpm | this work |
| **CPB-Fe** | Pig blood | -0.04 V /-10 mV | -0.16 V /-20 mV | SCE | 0.1 M KOHat 1600 rpm | this work |
| **N-doped****MWNT** | Melamine | -0.114 V /Ca. -30 mV | -0.184 V /-42 mV | SCE | 0.1 M KOHat 1600 rpm | [1](#_ENREF_1) |
| **PANI-4.Fe-HT2(SBA-15)** | Aniline | 0.95 V /-40 mV | 0.84 V /10 mV | RHE | 0.1 M KOHat 1600 rpm | [2](#_ENREF_2) |
| **N-doped****MWNT** | Pyridine | −0.135 V /-34 mV | - /- | SCE | 0.1 M KOHat 800 rpm | [3](#_ENREF_3) |
| **CoPy/C** | pyridine | 0.11 V /-100 mV | -0.117 V /- | Saturated calomel electrode | 0.1 M KOHat 1500 rpm | [4](#_ENREF_4) |
| **N-doped CNT/graphene** | NH3 | 0.88 V /-80 mV | - /- | RHE | 0.1 M KOHat 1225 rpm | [5](#_ENREF_5) |
| **Fe/Fe3C-melamine** | Melaminefoam | Ca. -0.05 V /Ca. -30 mV | - /- | Hg/HgO | 0.1 M KOHat 2000 rpm | [6](#_ENREF_6) |
| **N-doped****MWNT** | Melamine | -0.06 V /-30 mV | - /- | SCE | 0.1 M KOHat 1600 rpm | [7](#_ENREF_7) |
| **ZIF-derived carbons** | Zeolitic imidazolate frameworks | 0.861 V /-63 mV | 0.697 V /-103 mV | RHE | 0.1 M KOHat 1600 rpm | [8](#_ENREF_8) |
| **HP-NPCs-2** | Cyanamide | -0.03 V /-10 mV | - /- | Ag/AgCl | 0.1 M KOHat 1600 rpm | [9](#_ENREF_9) |
| **Hollow nitrogen-doped carbon spheres** | Iron(III) diethylenetriaminepentaacetate | -0.97 /-50 mV | 0.79V /-30 mV | RHE | 0.1 M KOHat 1600 rpm | [10](#_ENREF_10) |

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**The Koutecky-Levich (K-L) equation**

The K–L equation as given below:

 (1)

 (2)

where J denotes the measured current density, JK is the kinetic current density, JL is the diffusion-limited current density, ω is the electrode rotation rate, F is the Faraday constant (96485 C mol-1), C0 is the bulk concentration of O2 (1.2×10-3 mol L-1), D0 is the diffusion coefficient of O2 (1.9 ×10-5 cm2 s-1) and v is the kinetic viscosity of the electrolyte (1.0×10-2 cm2 s-1).



**Fig. S2** ORR polarization curves for CPB, CPB-Fe and Pt/C catalysts before and after continuous potential cycles for 5000 times from -0.4 to 0.2 V.