Supporting Information

Iodine-treated heteroatom-doped carbon: conductivity driven electrocatalytic activity

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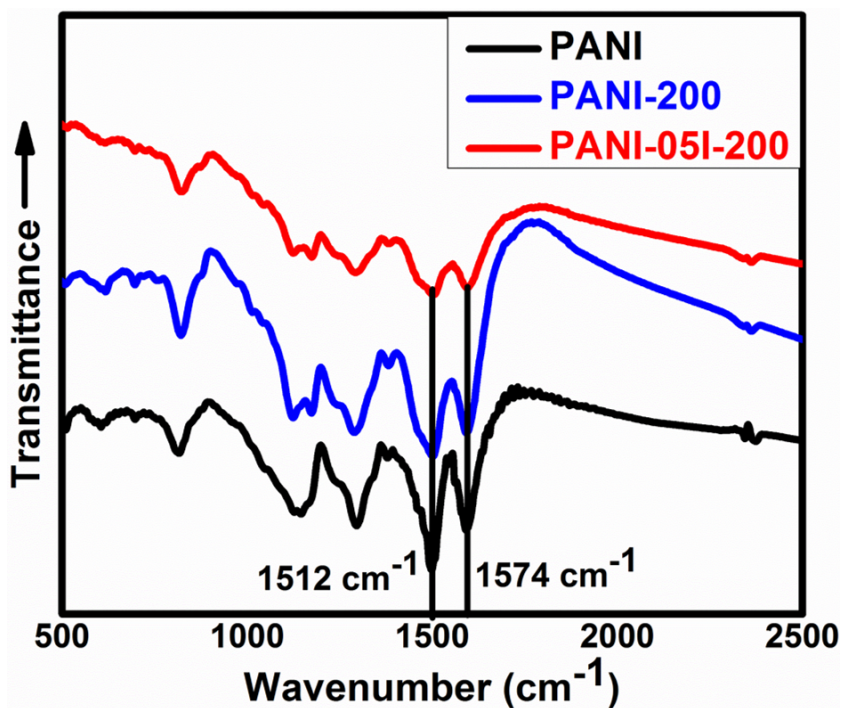**Summary**: This file contains 9 pages, 7 figures and 2 tables

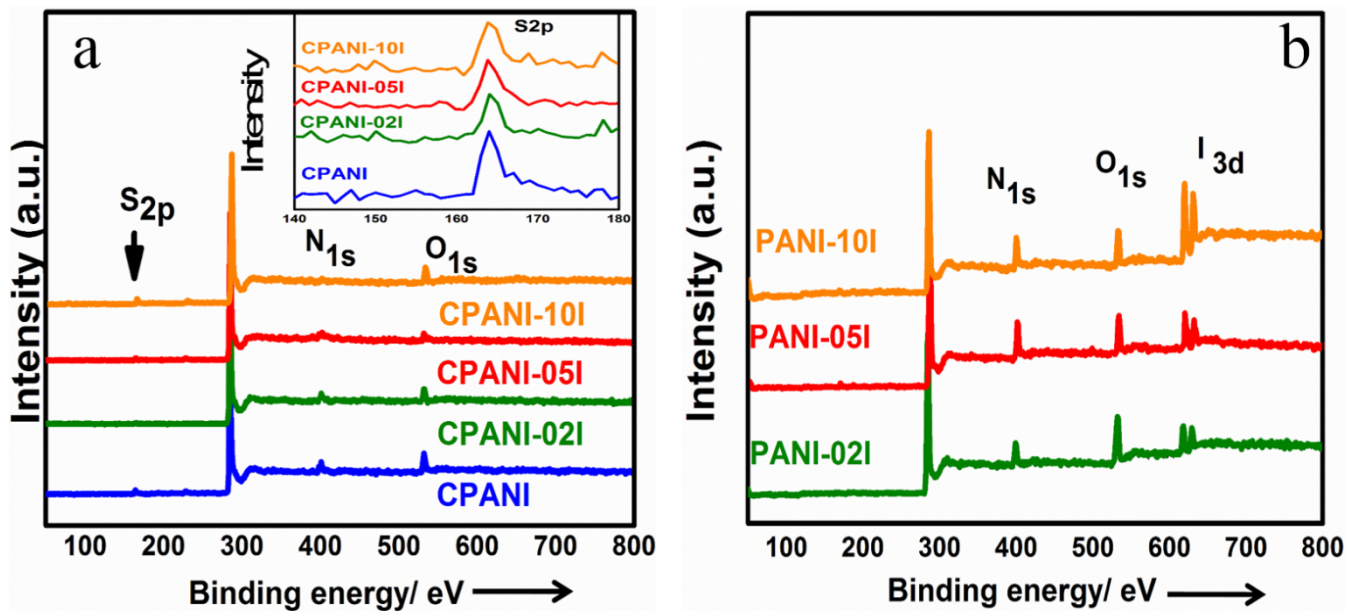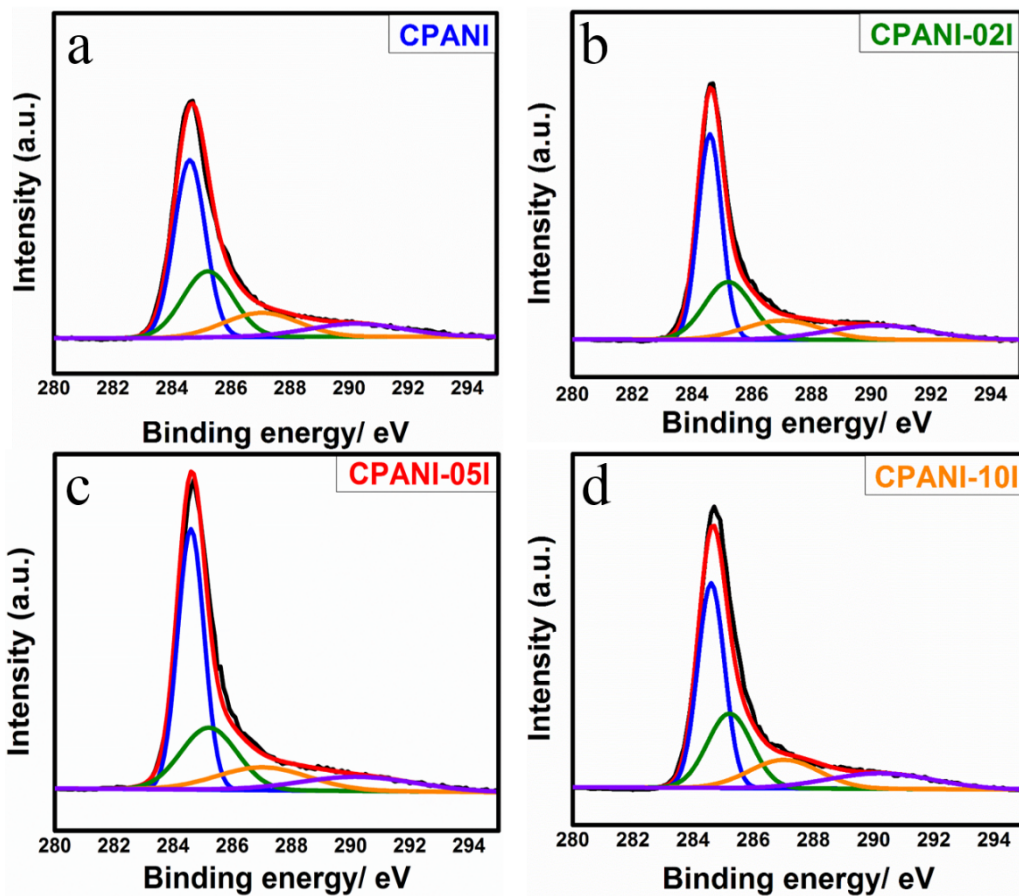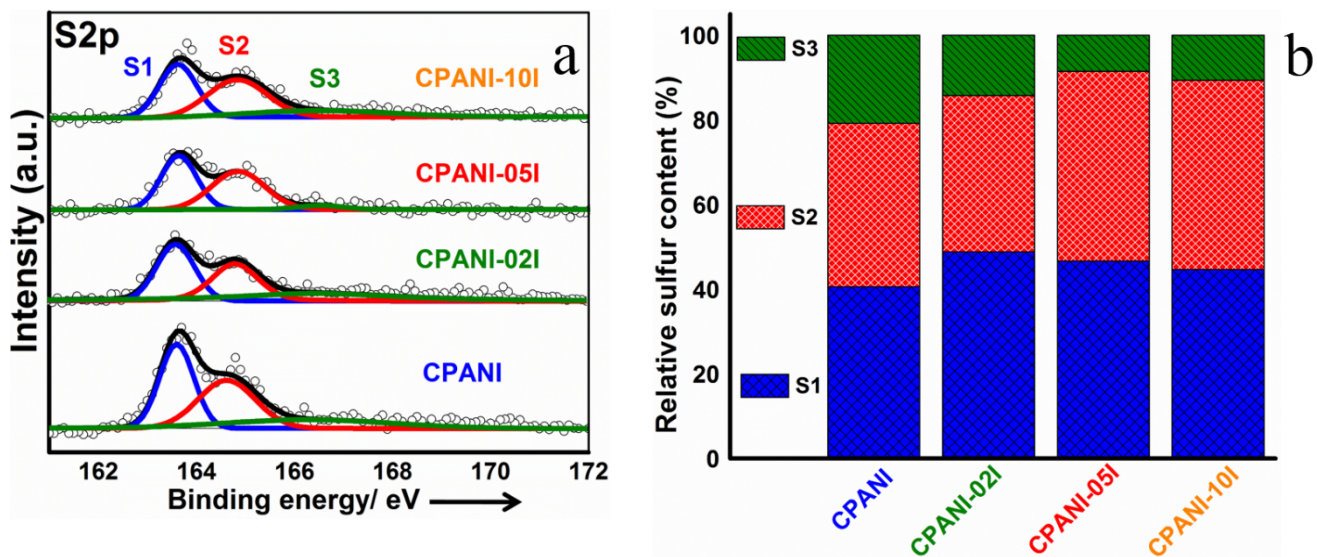**Fig. S1** FTIR spectra of PANI, PANI-200 and PANI-05I-200

Fig. S2 XPS spectra of a) CPANI, CPANI-02I, CPANI-05I and CPANI-10I and b) PANI, PANI-02I, PANI-05I and PANI-10I.

Fig. S3 Deconvoluted XPS spectra of C 1s for a) CPANI, b) CPANI-02I, C) CPANI-05I and d) CPANI-10I.

Fig. S4 (a) Deconvolution of S 2p into three main components, S1: (S P3/2), S2: (S P1/2) and S3: (SOx) and (b) distribution of major components of sulfur present in CPANI, CPANI-02I, CPANI-05I and CPANI-10I.
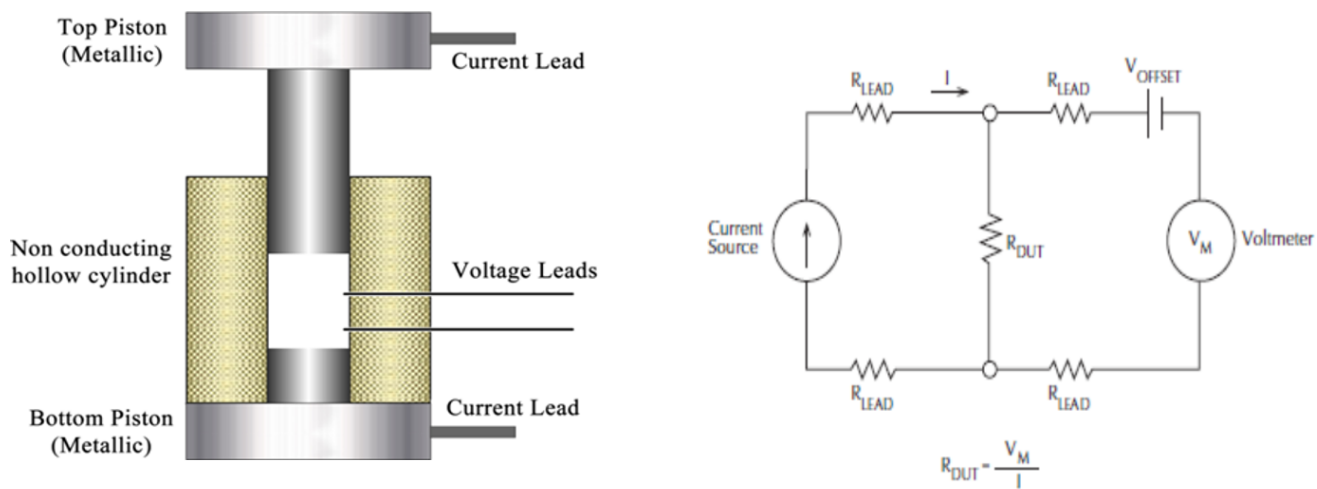
Fig. S5 Design of four probe apparatus used to measure conductivity of the powder carbon samples and circuit diagram of the resistance measurement technique.
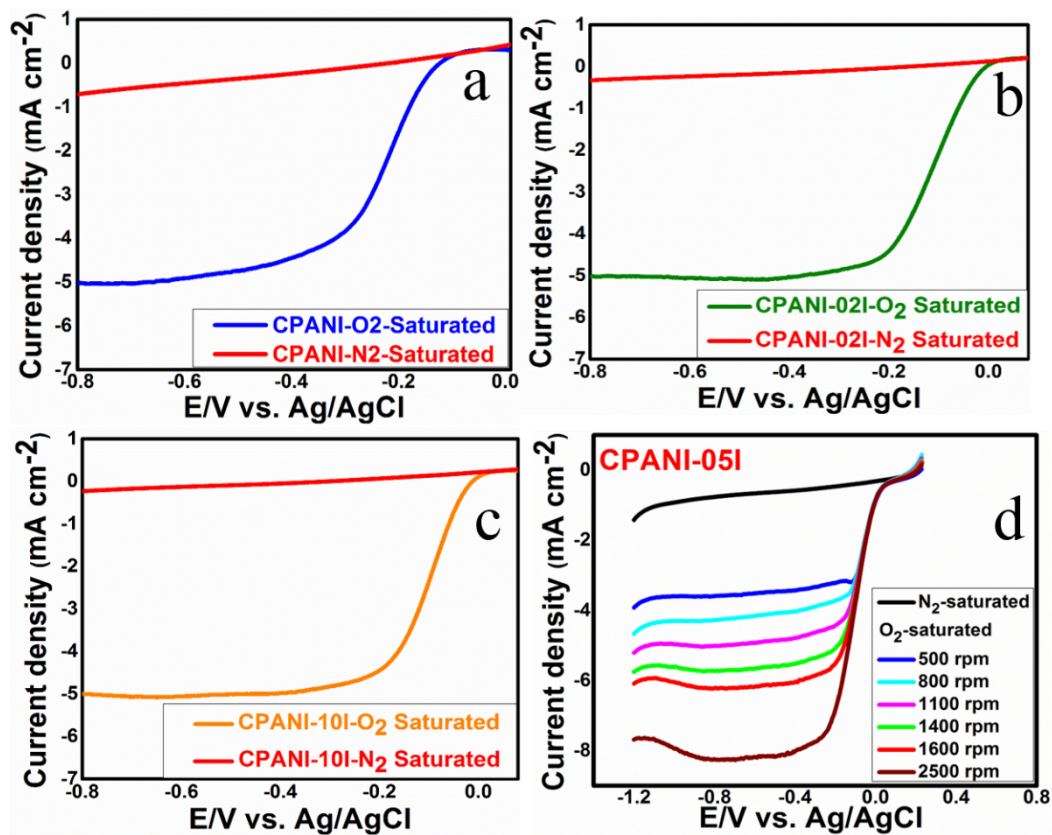
Fig. S6 Linear sweep voltammetry (LSV) curves of ORR in O_2- and N_2-saturated atmosphere at 1600 rpm for (a) CPANI, (b) CPANI-021 and (c) CPANI-10I, and (d) LSV curves of ORR at various rotation rates for CPANI-05I
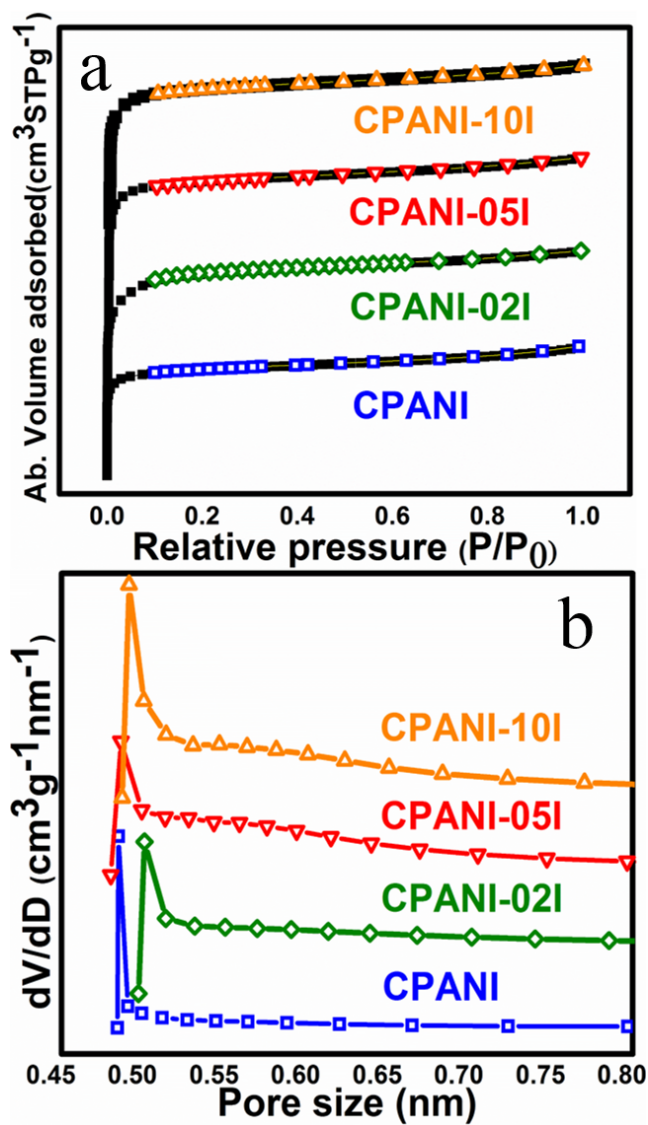
Fig. S7 (a) Nitrogen adsorption-desorption isotherms and (b) the corresponding pore size distribution curves of CPANI, CPANI-02I, CPANI-05I and CPANI-10I.

Table S1 Nitrogen sorption and electrochemical conductivity data of untreated CPANI and I-treated CPANI-02I, CPANI-05I and CPANI-10I

Sample	Physical characteristics					
	BET total surface area (m^2g^{-1})	Micropore surface area (m^2g^{-1})	Pore volume (cm^3g^{-1})	Micropore volume (cm^3g^{-1})	H-K pore size (nm)	Conductivity (S/cm) at 18 MPa
CPANI	855	811	0.38	0.36	0.48	6.50
CPANI-02I	1104	1058	0.48	0.42	0.50	14.05
CPANI-05I	1130	1082	0.48	0.41	0.48	19.77
CPANI-10I	1060	1011	0.40	0.38	0.49	17.87

Table S2 Comparison of ORR activities and kinetics of reported heteroatom-doped carbon catalysts with the iodine treated heteroatom-doped catalyst in this work.

Catalyst	Preparation method/Pyrolysis temperature	Electrolyte	Onset potential (V vs. Ag/AgCl)	Current density (mA/cm^{-2})	Peak Potential. (V)	Reference
I-treated heteroatom-doped carbon	**Pyrolysis of PANI in presence of iodine at 900 °C**	**0.1 M KOH**	**+0.021**	**5.71**	**-0.14**	**This work**
N-doped graphene	Annealing of GO/PANI composite at 1000°C	0.1 M KOH	N/A	N/A	-0.22	1
N-doped graphene	Heat treatment of graphite with 4-aminobenzoic acid and polyphosphoric acid/P$_2$O$_5$ at 170° C	0.1 M KOH	-0.13	N/A	N/A	2
Metal-free N-doped carbon aerogels made from ionic liquids	Carbonization of ionic liquid 1-ethyl-3-methylimidazolium dicyanamide mixed with the NaCl/ZnCl$_2$ at 1000 °C	0.1 M KOH	N/A	~6.0	-0.2	3
S-doped graphene	Annealing of GO and benzyl disulfide at 1050° C	0.1 M KOH	N/A	N/A	-0.29	4
N-S doped graphene	Annealing of melamine/ BDS/GO/SiO$_2$ mixture at 900°C	0.1 M KOH	-0.06	N/A	-0.24	5
N-S doped graphene	Dispersion of GO in thiourea solution which is autoclaved at 180° C. After freeze drying no carbonization was carried out	0.1 M KOH	-0.15	3.9	-0.36	6
N-S doped graphene	GO was heated with 2-aminothiophenol in presence of polyphosphoric acid at 200° C	0.1 M KOH	-0.129[a]	N/A	-0.40[a]	7
N-doped carbon from ionic liquids and nucleobases	By heating nonvolatile ionic liquids featuring dicyanamide anions to temperatures of 1000 °C	0.1 M KOH	0.035	N/A	-0.192	8
Edge-halogenated (I) graphene	Ball-milling of graphite in the presence of I$_2$	0.1 M KOH	-0.14	N/A	-0.22	9

| I-doped graphene | Pyrolysis of GO with I_2 at 1100°C | 0.1 M KOH | -0.08 | N/A | -0.29 | 10 |
| Fe containing N-doped carbon | Annealing of iron-compex (derived from bidppz and FeSO$_4$) at 800°C | 0.1 M KOH | -0.02[b] | 6.0[C] | -0.03[b] | 11 |

All the SCE[a] and RHE[b] potentials have been converted to the Ag/AgCl potential.

C. The corresponding current densities are estimated from figure in reported literature.

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