Electronic Supplementary Material (ESI) for CrystEngComm

Supporting Information

Temperature-dependent enhancement of oxygen reduction reaction activity for interconnected nitrogen-doped carbon shells

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Table S1 C, N and O content of the samples

	C(%)	N(%)	O(%)
C-600	67.4	9.6	21.5
C-700	66.1	9.3	22.3
C-800	67.2	8.9	21.9
C-900	79.7	4.2	14.8

Figure S1 CV curves of Pt-C electrode at a scan rate of 10 mVs^{-1} in O_2 and O_2-saturated 0.1M KOH solution with 3M methanol

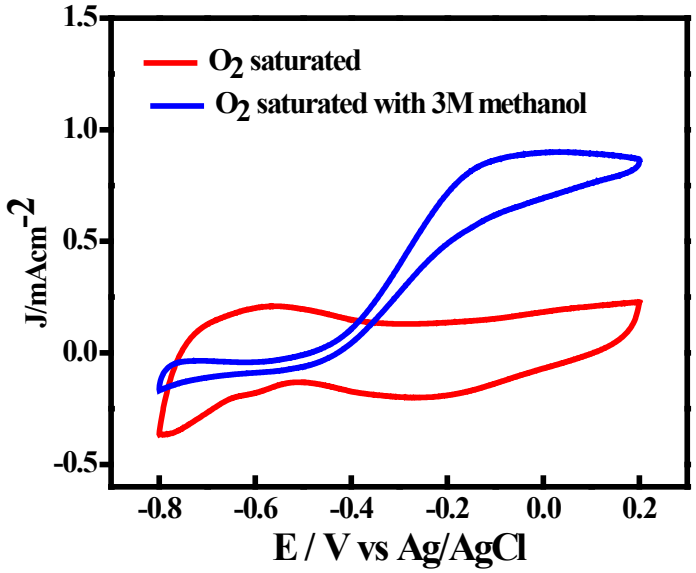
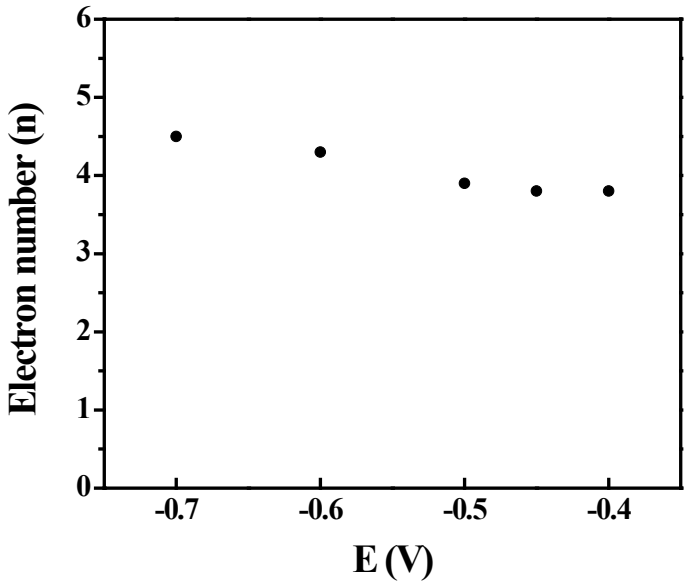


Figure S2 The dependence of n on potential for the C-800 electrode



For a more quantitative evaluation of the ORR electrocatalytic activity for the as obtained nanoshells, rotation-rate-dependent RDE measurements were performed using the Koutecky-Levich equation. [S1, S2] This equation was used to determine the number of electrons involved in oxygen reduction using carbon shells. This equation is valid for a first-order process with respect to the diffusion species, and the current density j is related to the rotation rate ω of the electrode according to

$$\frac{1}{j}=\frac{1}{j_k}+\frac{1}{B\omega^{0.5}} \qquad \text{(S1)}$$

where j_k is the kinetic current and B is Levich slope that is given by

$$B=0.2nF(D_{O_2})^{2/3}v^{-1/6}C_{O_2} \qquad \text{(S2)}$$

Here n is the number of electrons transferred in the reduction of one O_2 molecule, F is the Faraday constant (F = 96485 C/mol), DO_2 is the diffusion coefficient of O_2 in 0.1M KOH (DO2 =1.9 $\times 10^{-5}$ cm^2 /s), v is the kinematics viscosity for KOH (v = 0.01 cm^2 /s) and CO_2 is concentration of O_2 in the solution (CO_2 = 1.2 $\times$ 10^{-6} mol/cm^3). The constant 0.2 is adopted when the rotation speed is expressed in rpm. The corresponding curves were plotted for different potentials in Figure 4C.

Figure S3 Rotating ring-disk electrode (RRDE) voltammograms for oxygen reduction in O_2-saturated 0.1M KOH for C-800 electrode at 1200 rpm

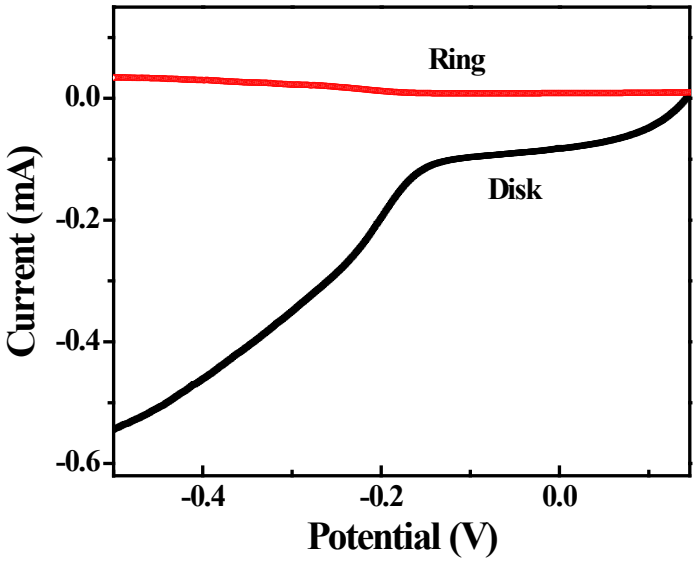


Figure S4 CVs of C-Ni-800 on a GC electrode in N_2–saturated and O_2–saturated 0.1 M KOH.

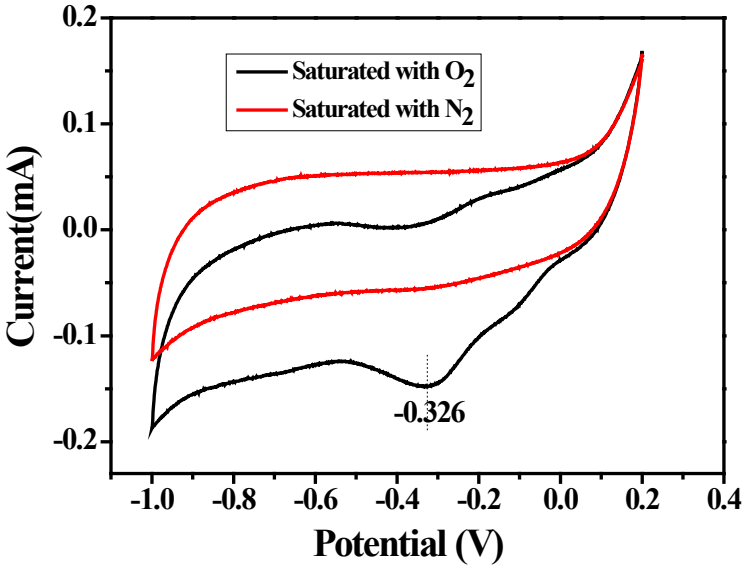


Figure S5 XPS spectra of O 1s for the four carbon shell samples annealed at 600–900 °C

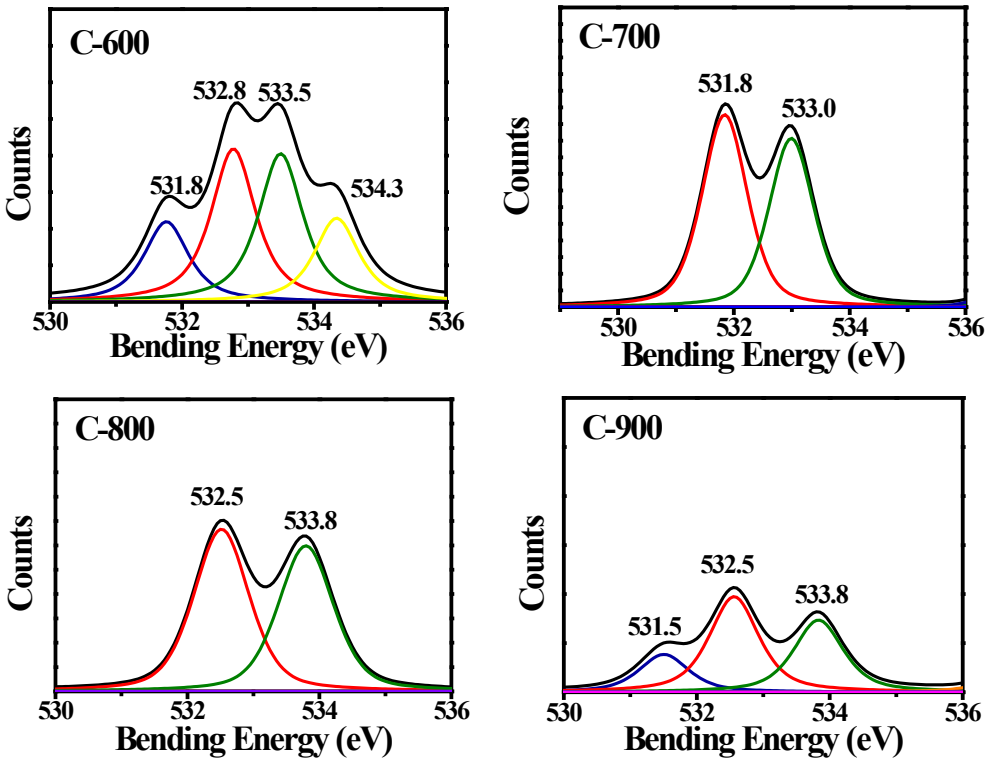
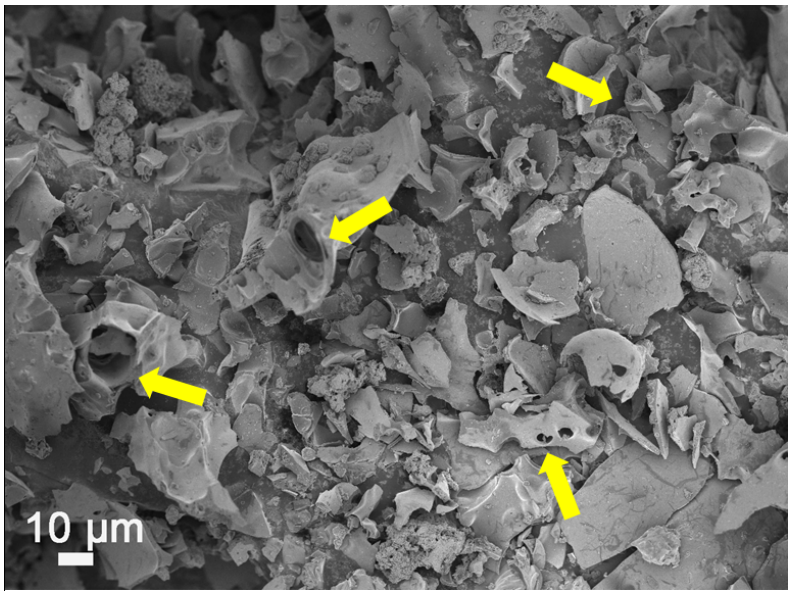


Figure S6 SEM images of the sample with obvious holes at inner structure (yellow arrows) after annealing at 400℃.



References

S1. K. P. Gong, F. Du, Z. H. Xia, M. Durstock and L. M. Dai, *Science* 2009, **323**, 760-764.

S2. L. T. Qu, Y. Liu, J. B. Baek and L. M. Dai, *ACS Nano* 2010, **4**, 1321-1326.