Electronic Supplementary Material (ESI) for Materials Advances.

Supporting information

Investigating the effect of CeO_2 on the radical scavenging activity of Pt@CoOx/NC@CeO_2 during the electrocatalytic oxygen reduction reaction in acidic and alkaline environments

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Determination of electron number

For the determination of electron number, Koutechy-Levich (K-L) plots were drawn at different potentials from which electron number was calculated according to the formula given below.[1]

$$\frac{1}{j} = \frac{1}{jd} + \frac{1}{jk}$$

$$\frac{1}{j} = \frac{1}{B\sqrt{W}} + \frac{1}{jk}$$

$$jd = 0.62nFC_0\,(D_0)^{2/3}\,(V)^{-1/6}$$

ECSA measurement

Electrochemical active surface area was calculated from palladium oxide layer reduction curve at potential limit of 1.4 V_{RHE} according to the following formula.[2]

$$ECSA = \frac{Q_0}{q^{o}}$$

$$Q^0 = Charge\ contaimed\ in\ the\ CV\ curve$$

$$q^0 = standard\ value\ for\ Pd - based\ catalysts$$

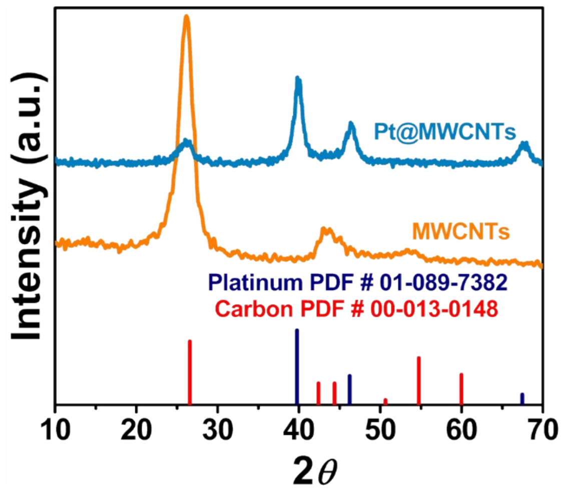

Figure S1. PXRD pattern of MWCNTs and Pt@MWCNTs1

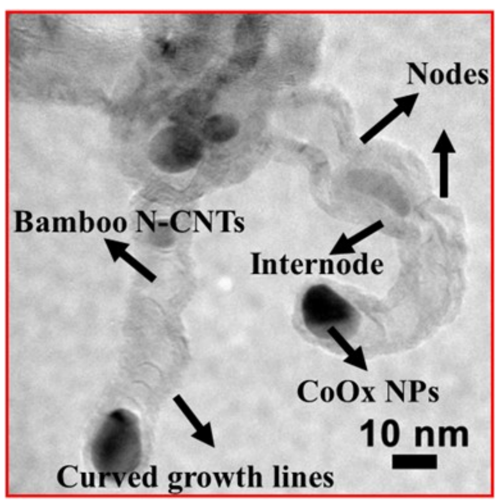

Figure S2. HRTEM image of CoOx/NC at 10 nm

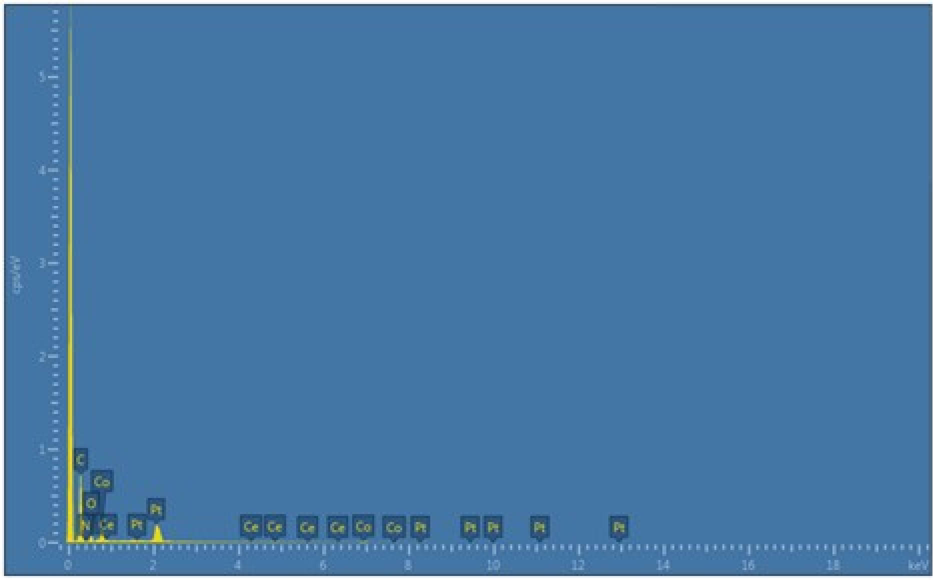

Figure S3. EDX analysis of Pt@CoOx/NC@$CeO_2$1

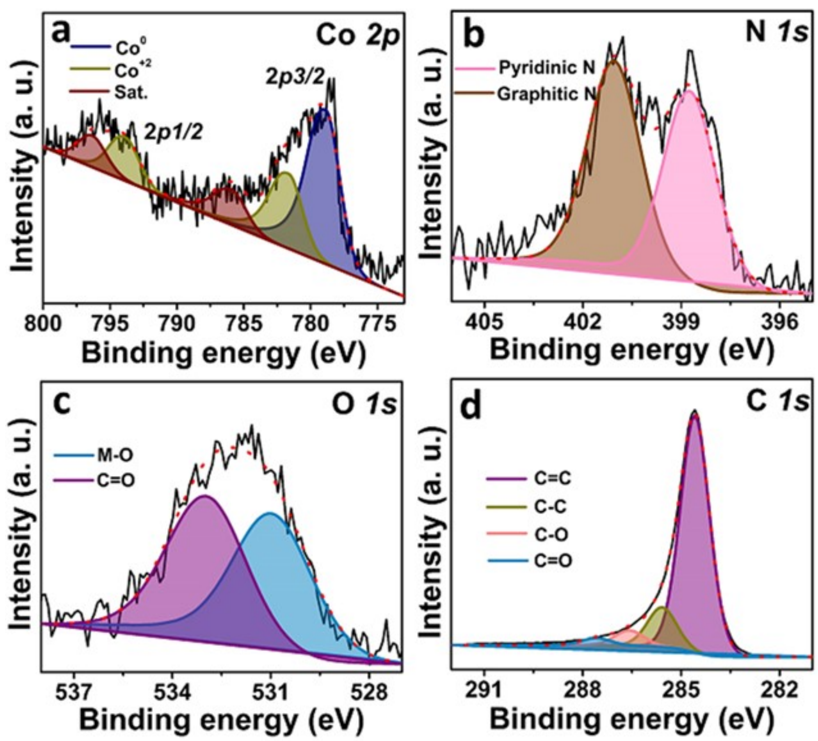

Figure S4. XPS spectrum of CoOx/NC (a) Co 2p (b) N 1s (c) O 1s (d) C 1s[3]

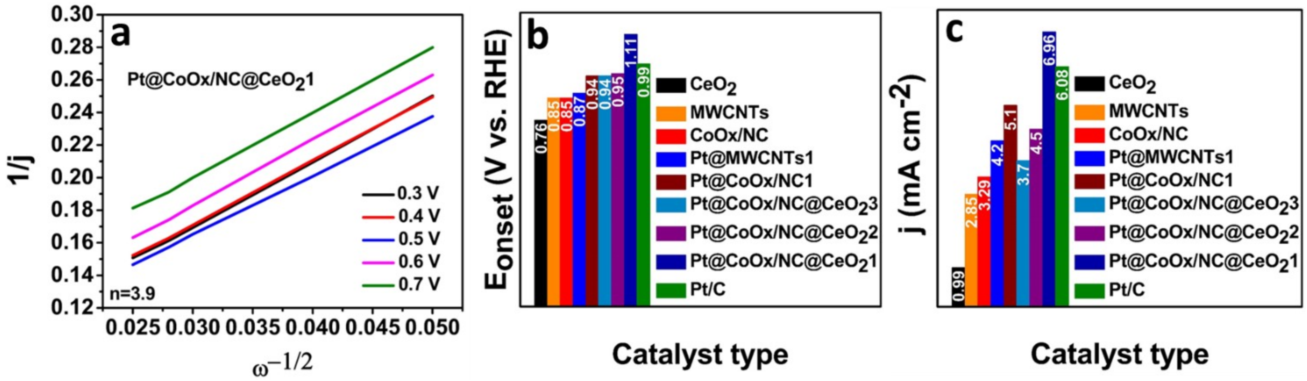

Figure S5. (a) K-L plot of Pt@CoOx/NC@$CeO_2$1 in 0.1M KOH (b) compariosn of E_{onset} of the synthesized catalysts with 20 wt% Pt/C in 0.1M KOH (c) compariosn of current density of the synthesized catalysts with 20 wt% Pt/C in 0.1M KOH

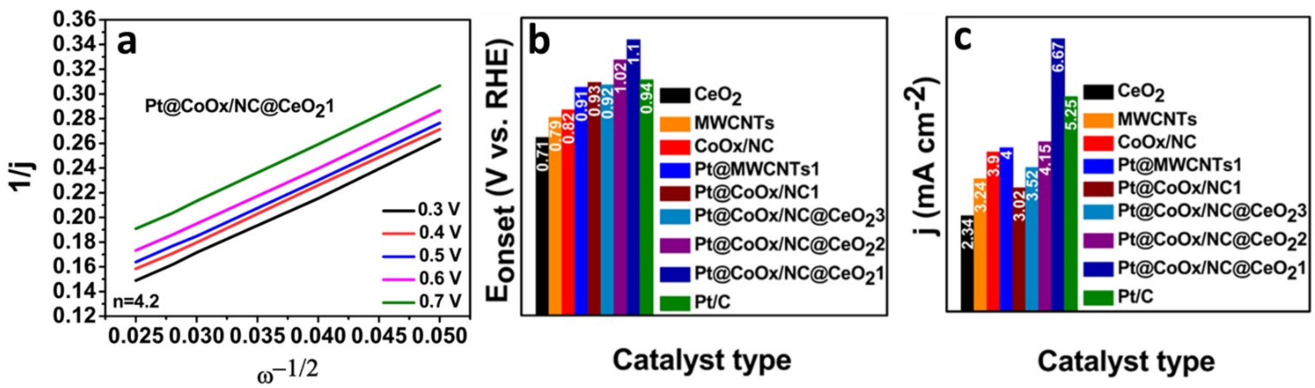

Figure S6. (a) K-L plot of Pt@CoOx/NC@$CeO_2$1 in 0.1M $HClO_4$ (b) compariosn of E_{onset} of the synthesized catalysts with 20 wt% Pt/C in 0.1M $HClO_4$ (c) compariosn of current density of the synthesized catalysts with 20 wt% Pt/C in 0.1M $HClO_4$

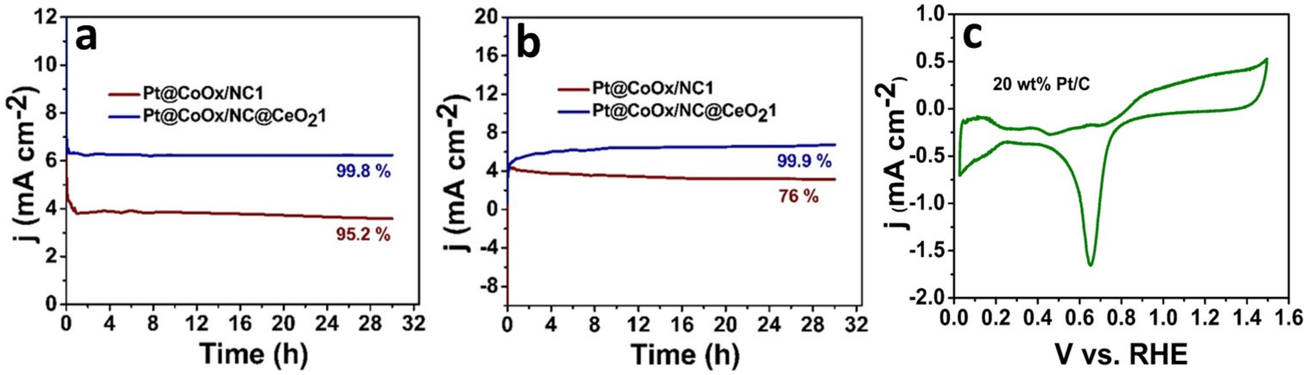

Figure S7. Chronoamperometric results of Pt@CoOx/NC1 and Pt@CoOx/NC@$CeO_2$1 in 0.1 M KOH (b) chronoamperometric results of Pt@CoOx/NC1 and Pt@CoOx/NC@$CeO_2$1 in 0.1 M $HClO_4$ (c) Pt-O layer reduction curve of 20 wt% Pt/C at 1.4 V_{RHE} in 0.1 M $HClO_4$ at a scan rate of 50 mV s^{-1} in Ar saturated environment

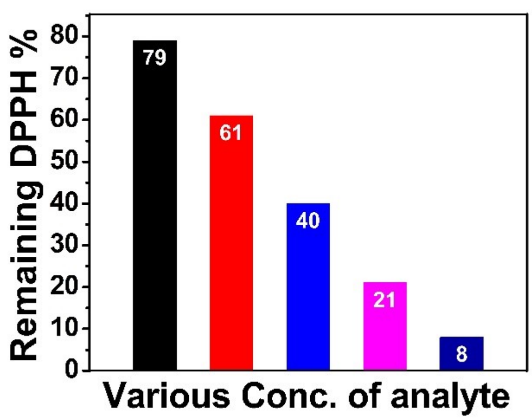

Figure S8. Remaining % of DPPH after being incubated with different concentrations of Pt@CoOx/NC@$CeO_2$1

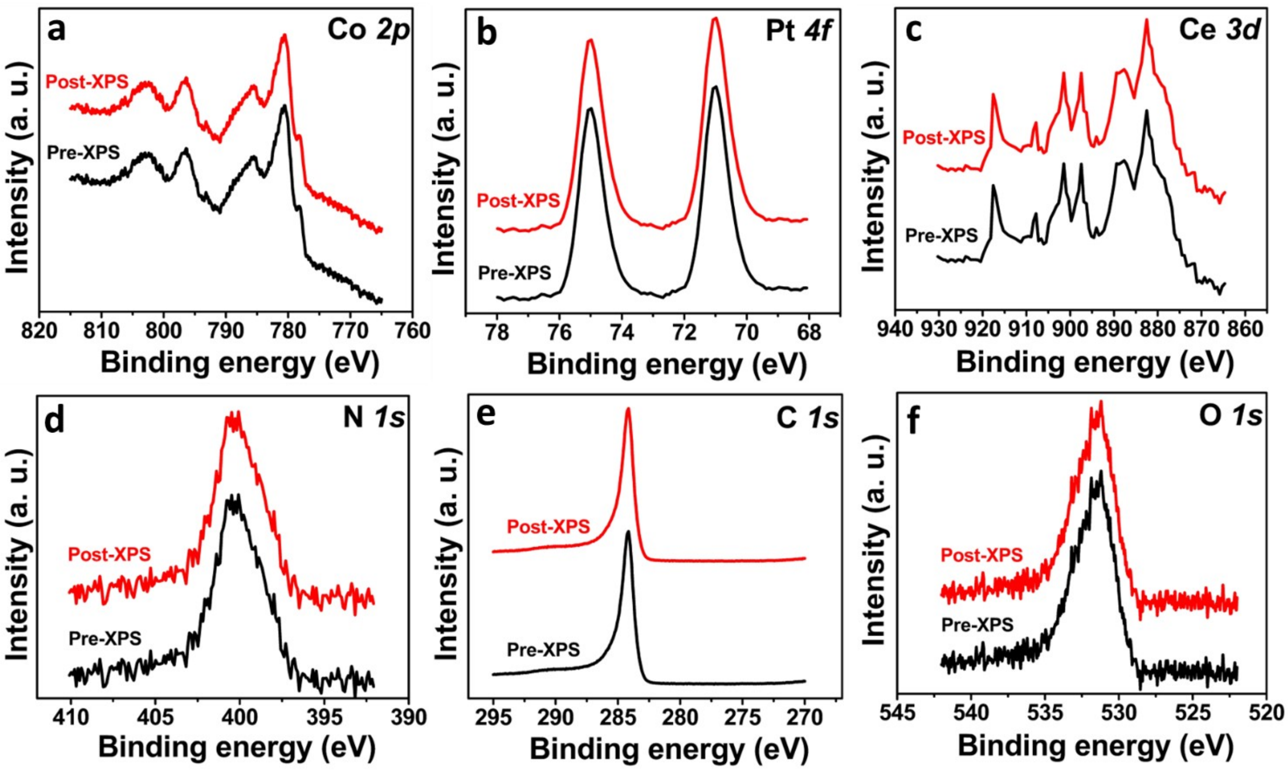

Figure S9. Comparison of Pre and Post XPS analysis of Pt@CoOx/NC@$CeO_2$1 after chronoamperometric measurements (a) Co 2p (b) Pt 4f (c) Ce 3d (d) N 1s (e) C 1s (f) O 1s

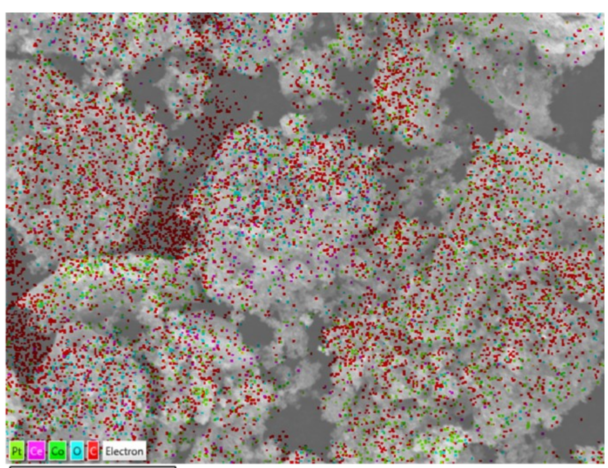

Figure S10. SEM analysis of Pt@CoOx/NC@$CeO_2$1 after chronoamperometric measurements

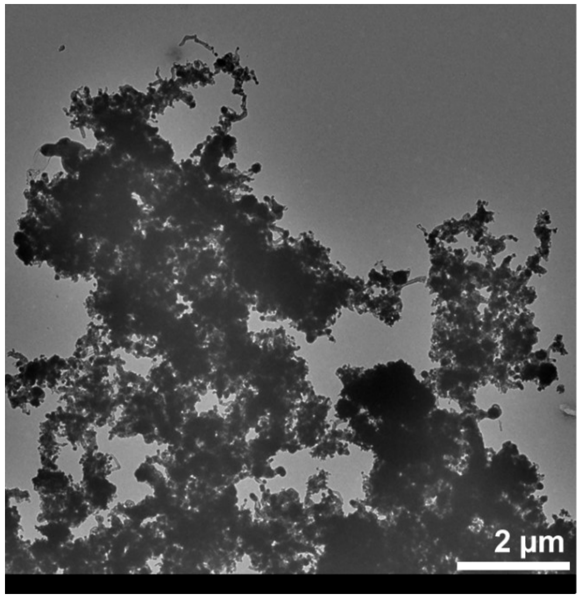

Figure S11. TEM analysis of Pt@CoOx/NC@$CeO_2$1 after chronoamperometric measurements

References

1. Khan, I. A.; Qian, Y.; Badshah, A.; Nadeem, M. A.; Zhao, D., Highly porous carbon derived from MOF-5 as a support of ORR electrocatalysts for fuel cells. *ACS Appl. Mater. Interfaces* **2016,** *8* (27), 17268-17275.

2. Fang, L.-l.; Tao, Q.; Li, M.-f.; Liao, L.-w.; Chen, D.; Chen, Y.-x., Determination of the real surface area of palladium electrode. *Chinese J. Chem. Phys.* **2010,** *23* (5), 543-548.

3. Khan, I.; Nasim, F.; Choucair, M.; Ullah, S.; Badshah, A.; Nadeem, M., Cobalt oxide nanoparticle embedded N-CNTs: lithium ion battery applications. *RSC Adv.* **2016,** *6* (2), 1129-1135.