

Electronic Supplementary Information of

Hybrids based on transition metal phosphide (Mn₂P, Co₂P, Ni₂P) nanoparticles and heteroatom-doped carbon nanotubes for efficient oxygen reduction reaction

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Koutechy_Levich equation:

$$\frac{1}{J} = \frac{1}{J_K} + \frac{1}{B\omega^{0.5}} \quad (i)$$

J_k represents the kinetic current and ω is the electrode rotating rate (rpm).

$$B = 0.2nF(D_{O_2})^{3/2}\nu^{-1/6}C_{O_2} \quad (ii)$$

B could be determined from the slope of K-L plots by equation (i), F is the Faraday constant ($F = 96485 \text{ C/mol}$), D_{O_2} represents the diffusion coefficient of O_2 in 0.1 M KOH ($1.9 \times 10^{-5} \text{ cm}^2/\text{s}$), ν is the kinetic viscosity ($0.01 \text{ cm}^2/\text{s}$), and C_{O_2} represents the bulk concentration of O_2 ($1.2 \times 10^{-6} \text{ mol/cm}^3$). n is the transferred electron transfer number per oxygen molecule, and could be calculated via equation (i) and (ii).

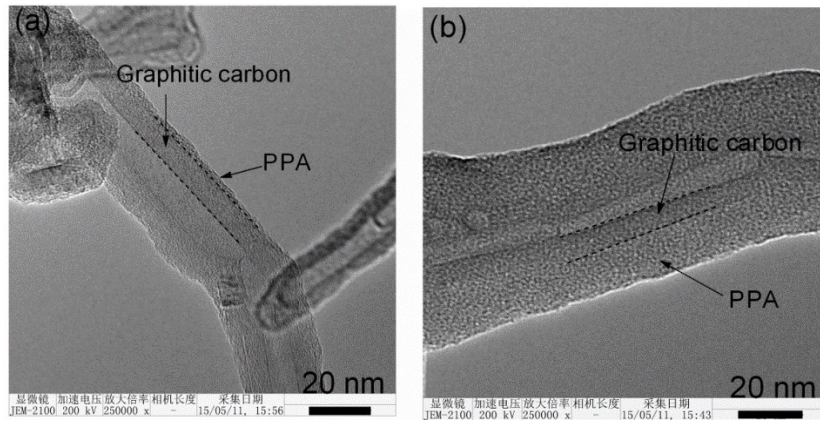


Fig. S1TEM images of CNTs@PPA with different PPA contents. (a) $m_{\text{CNTs}}: m_{\text{HCCP}}: m_{\text{P-PDA}}=4:1:1$, (b) $m_{\text{CNTs}}: m_{\text{HCCP}}: m_{\text{P-PDA}}=1:1:1$

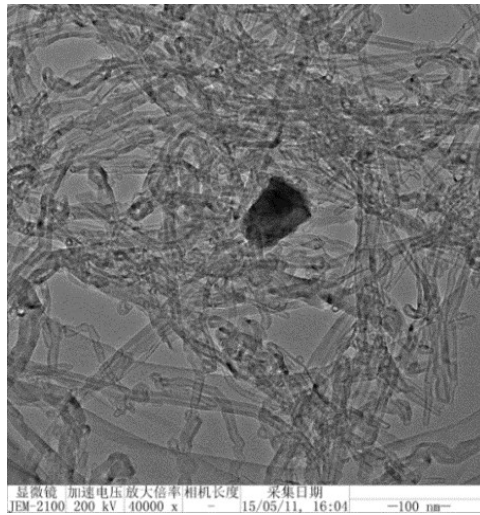


Fig. S2 TEM images of pristine MWCNTs load with cobalt compound carbonized at 900 °C.

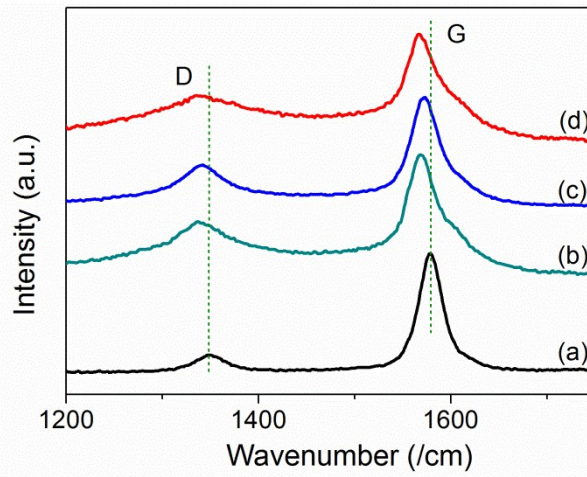


Fig. S3 Raman spectra of (a) HCNTs, (b) HCNTs-Co₂P, (c) HCNTs-Mn₂P and (d) HCNTs-Ni₂P

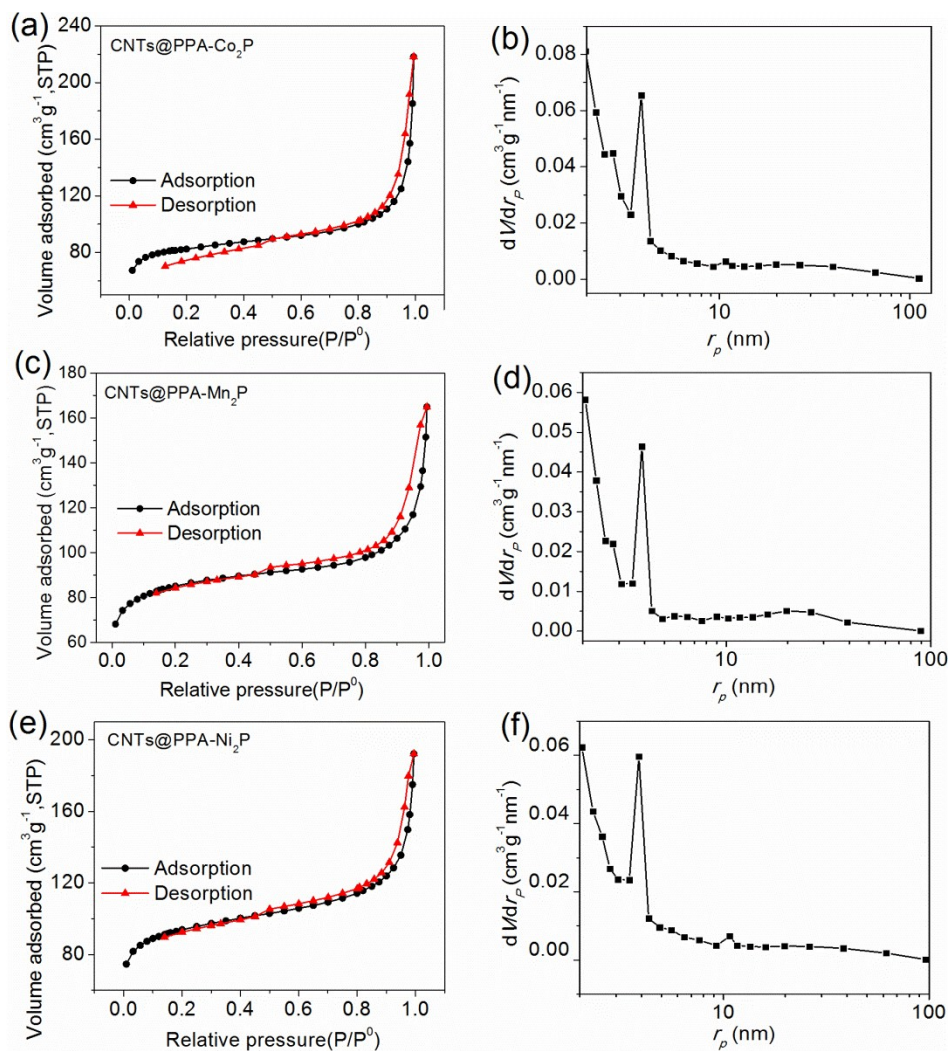


Fig. S4 Nitrogen adsorption–desorption isotherms of HCNTs-Co₂P(a), HCNTs-Mn₂P (c) and HCNTs-Ni₂P (e), and their corresponding pore size distribution (b, d, f)

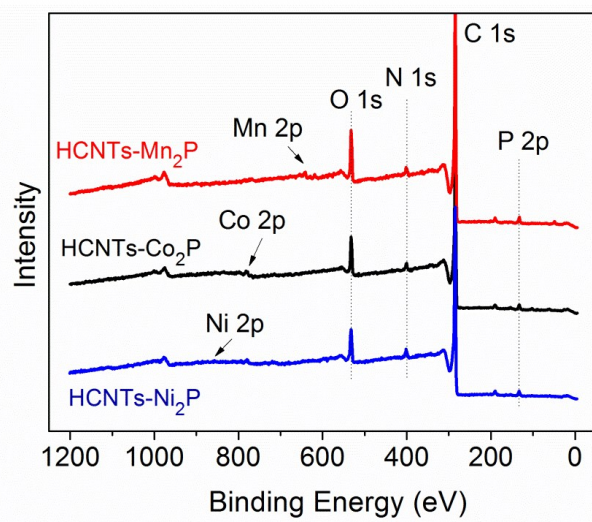


Fig. S5 Wide survey XPS spectra of the samples

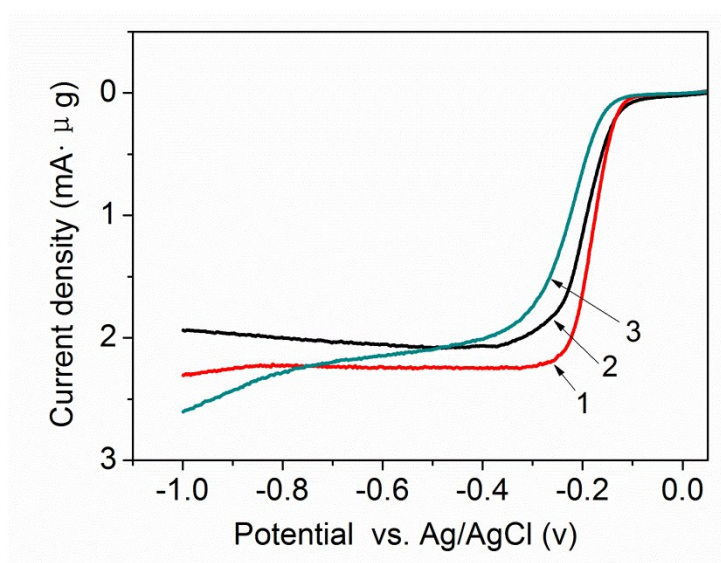


Fig. S6 Metal-mass-specific linear sweep voltammograms of HCNTs-Co₂P (1), HCNTs-Mn₂P (2), HCNTs-Ni₂P (3) at a rotation rate of 1800 rpm in O₂-saturated 0.1 M KOH solution. The metal mass was estimated based on the XPS results.

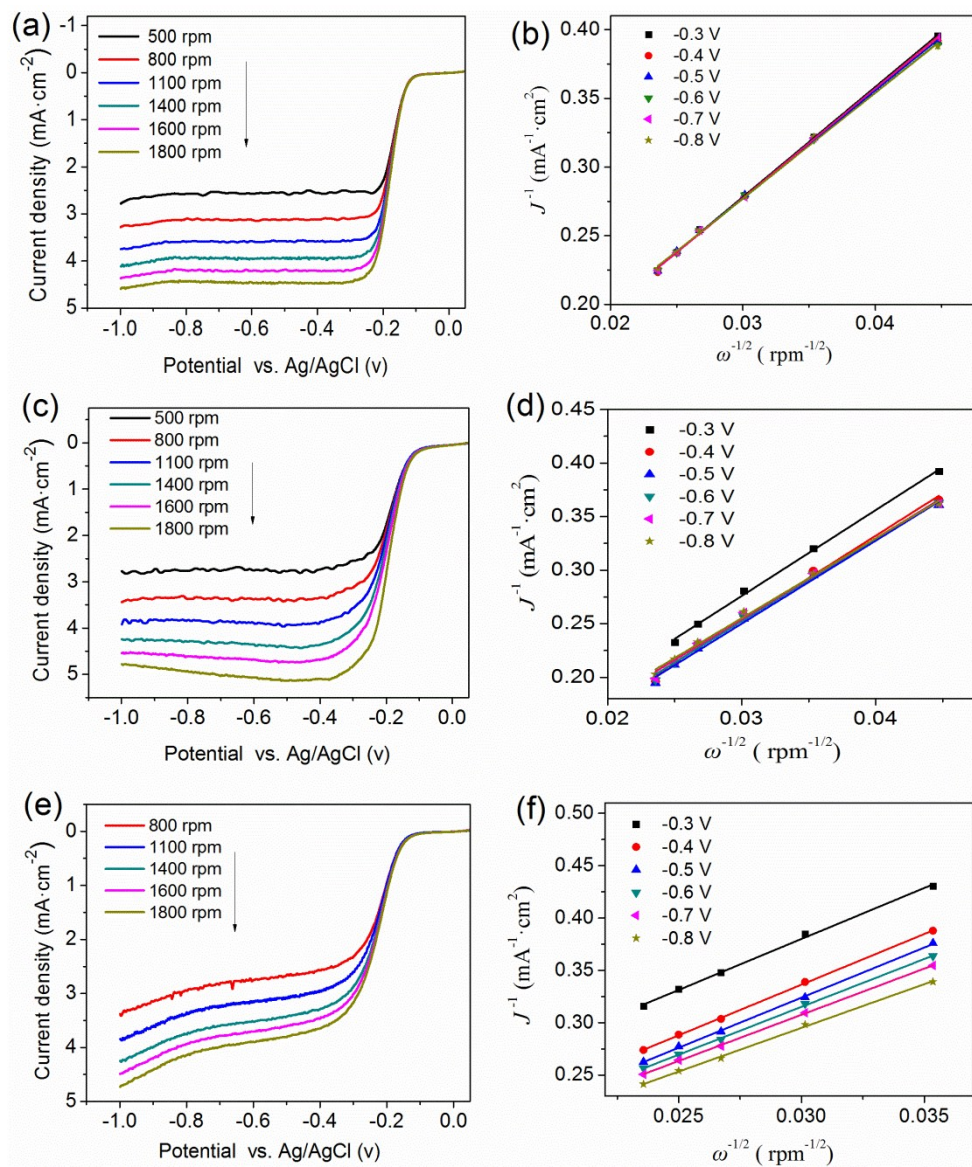


Fig. S7 Linear sweep voltammograms (LSVs) curves of HCNTs-Co₂P (a), HCNTs-Mn₂P (c) and HCNTs-Ni₂P (e) at various rotating rates in O₂ saturated 0.1 M KOH and the corresponding Koutecky-Levich plots recorded at selected potentials (b, d, f)

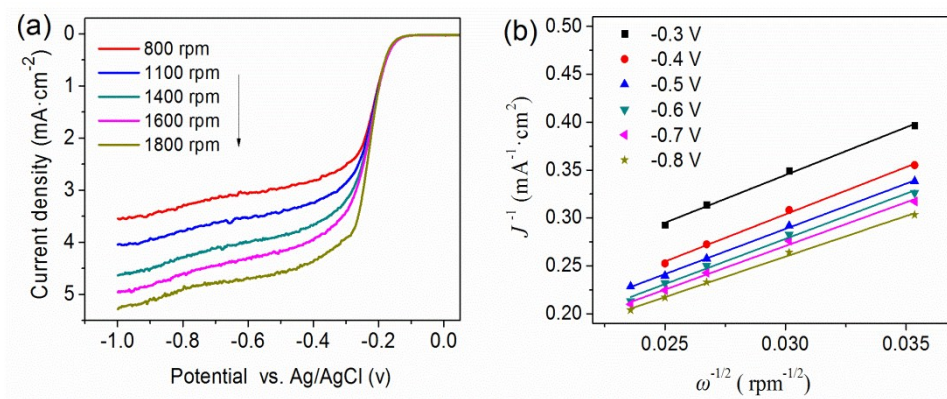


Fig. S8 (a) LSVs curves of HCNTs at various rotating rates in O₂ saturated 0.1 M KOH and (b) the corresponding Koutecky-Levich plots recorded at selected potentials