Electrocatalytic Activity of Nitrogen-Enriched Mesoporous Carbon Framework and its Hybrids with Metal Nanoparticles Fabricated through Pyrolysis of Block Copolymers

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Koutecky-Levich plots

$$\frac{1}{j}=\frac{1}{j_L}+\frac{1}{j_k} \quad (1)$$

in which j (mA/cm^2) is the measured current density, j_k denotes the kinetic current density and j_L is the limiting diffusion current density given by

$$j_L = Bw^{1/2} \quad (2)$$

here ω is the angular velocity of the rotating disk (ω=2πR where R is the linear speed/rpm of rotation) and B is the Levich parameter, which can be used to calculate the number (n) of electrons transferred for each oxygen molecule as follows,

$$B = 0.62nFD^{2/3}\nu^{-1/6}C_0 \quad (3)$$

in which F is the faradaic constant (86486 C mol^{-1}), D is the diffusion coefficient of O_2 in the electrolyte (1.73×10^{-5} cm^2 s^{-1}) in KOH (0.1 M), ν is the kinematic viscosity of the electrolyte (0.01 cm^2 s^{-1}) and C_0 is the concentration of oxygen (1.21×10^{-6} mol L^{-1}). From equations (1 and 2), n and j_k were obtained from the slope and the ordinate intercept of the K–L plots of j^{-1} versus $w^{-1/2}$ at a given potential.

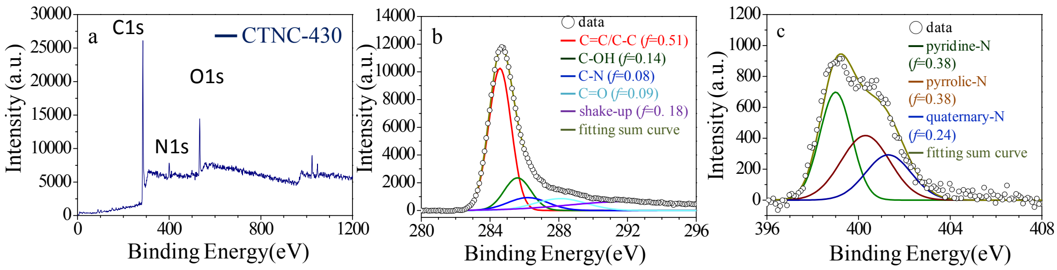

Figure S1 (a) XPS survey spectrum, (b) C1s spectrum and (c) N1s spectrum of $NEMCF_{430}$

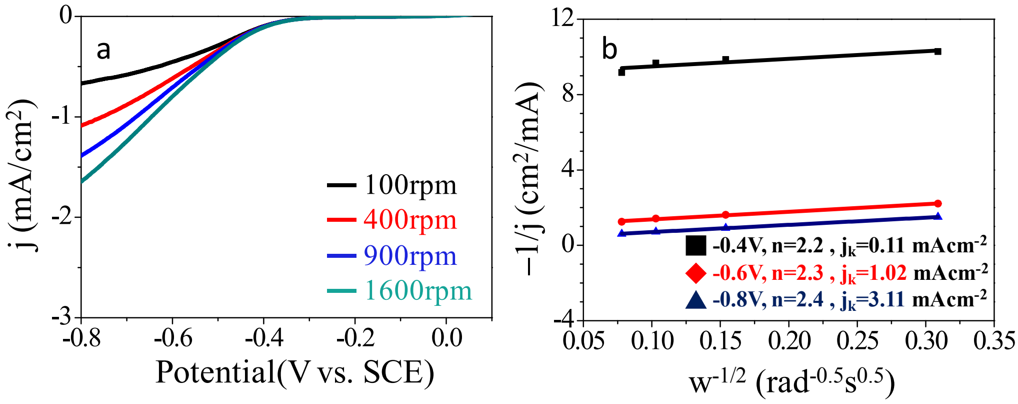

Figure S2 (a) RDE voltammograms recorded for $NEMCF_{400}$ supported on a GC electrode in an O_2-satutated 0.1 M KOH solution at a scan rate of 10 mV s^{-1} and different rotation rates; (b) Kouteckt-Levich plots of j^{-1} vs $w^{-1/2}$ at −0.4, −0.6 and −0.8V obtained from (a).

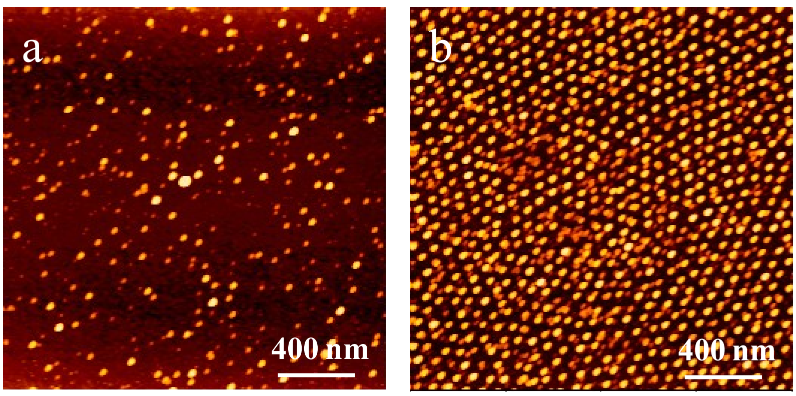

Figure S3 AFM topographic images of Ag NPs after PS-*b*-P2VP BCPs are loaded with (a) 0.1 M $AgNO_3$ in ethanol and (b) 0.1 M $Ag(NH_3)_2$+ ions in an aqueous solution for 30 min and then subjected to 30-min Ar plasma for reduction of Ag ions and removal of the BCP templates.

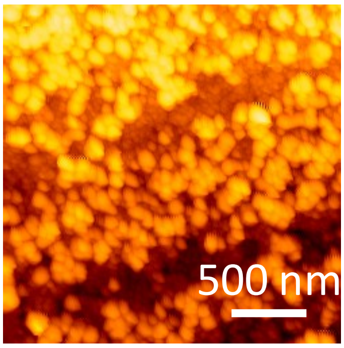

Figure S4 AFM topographic image of Ag@NEMCF$_{430}$.

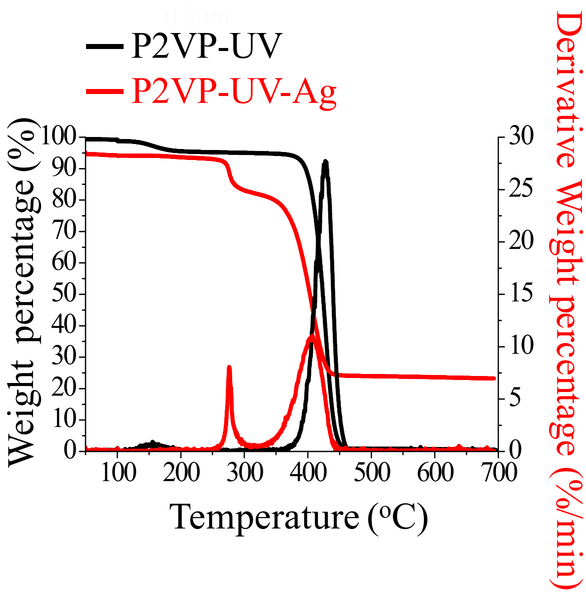

Figure S5 thermogravimetry analysis (TGA) and differential thermogravimetry (DTG) curves of the P2VP homopolymer and its hybrid loaded with Ag NPs (Ag@P2VP).

Figure S5 indicates TGA and DTG curves of the neat P2VP homopolymer and its hybrid loaded with Ag NPs. The decomposition temperature (T_d) of P2VP occurred at 427.6 °C while Ag@P2VP reveals two T_ds. One T_d is at 276.3°C and the other T_d is at 407.6 °C.

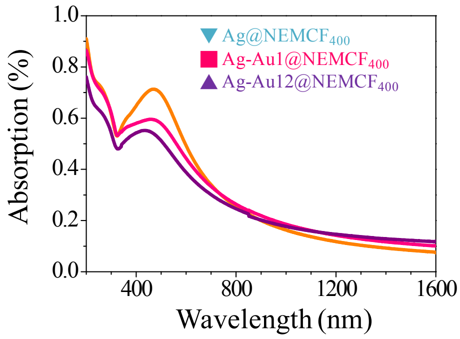

Figure S6 UV-vis absorption of Ag@NEMCF$_{400}$, Ag-Au$_1$@NEMCF$_{400}$ and Ag-Au$_{12}$@NEMCF$_{400}$.

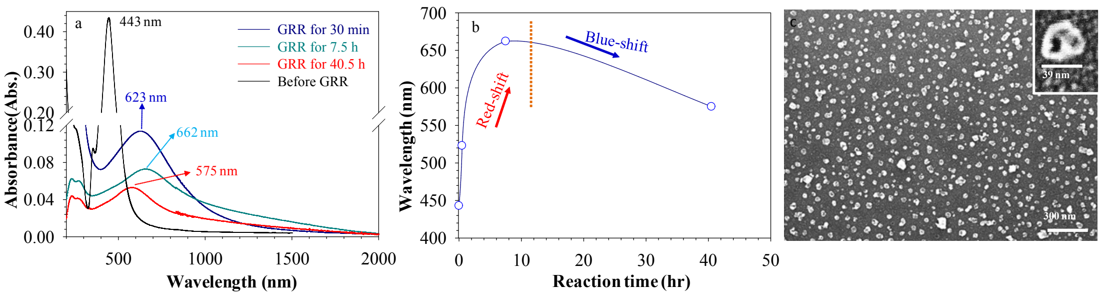

Figure S7 (a) UV-vis absorption of Ag and Ag-Au NPs generated via GRR of varied time periods, (b) time-dependent position of the absorption peak extracted from (a) and SEM of Ag-Au NPs generated by 30min-GRR.

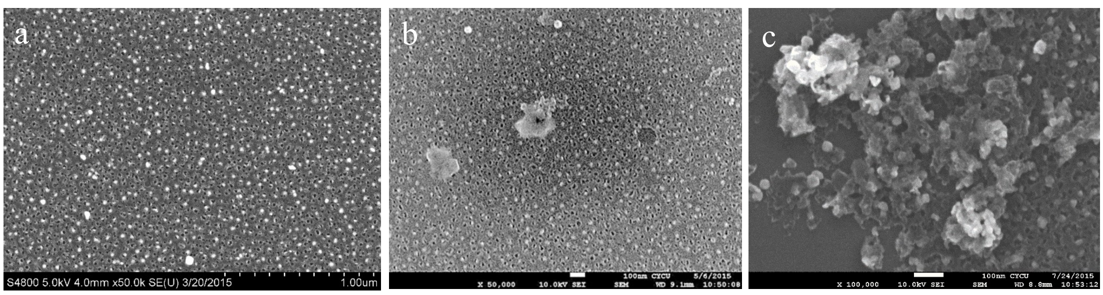

Figure S8 SEM images of (a) Ag@NEMCF400, (b) Ag-Au$_1$@NEMCF$_{400}$ and (c) Ag-Au$_{12}$@NEMCF$_{400}$.

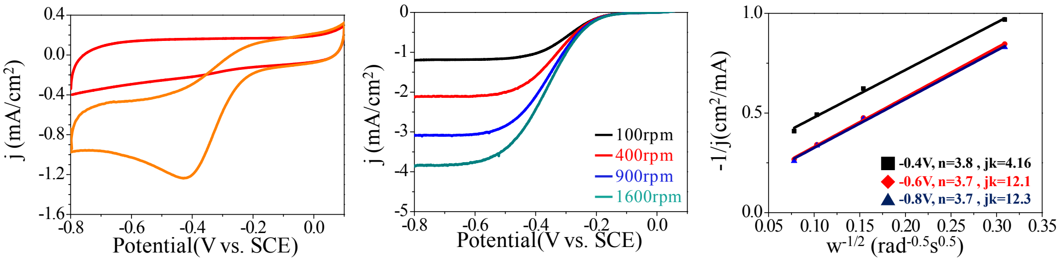

Figure S9 (a) cyclic voltammgram of Ag@NEMCF$_{430}$ at a scan rate of 100 mV cm^{-1} in N_2- or O_2-saturated 0.1 M KOH solutions (b) RDE voltammograms recorded for Ag@NEMCF$_{430}$ supported on a GC electrode in an O_2-satutated 0.1 M KOH solution at a scan rate of 10 mV s^{-1} and different rotation rates; (c) K-L plots of j^{-1} vs $w^{-1/2}$ at –0.4, –0.6 and –0.8V obtained from (b).

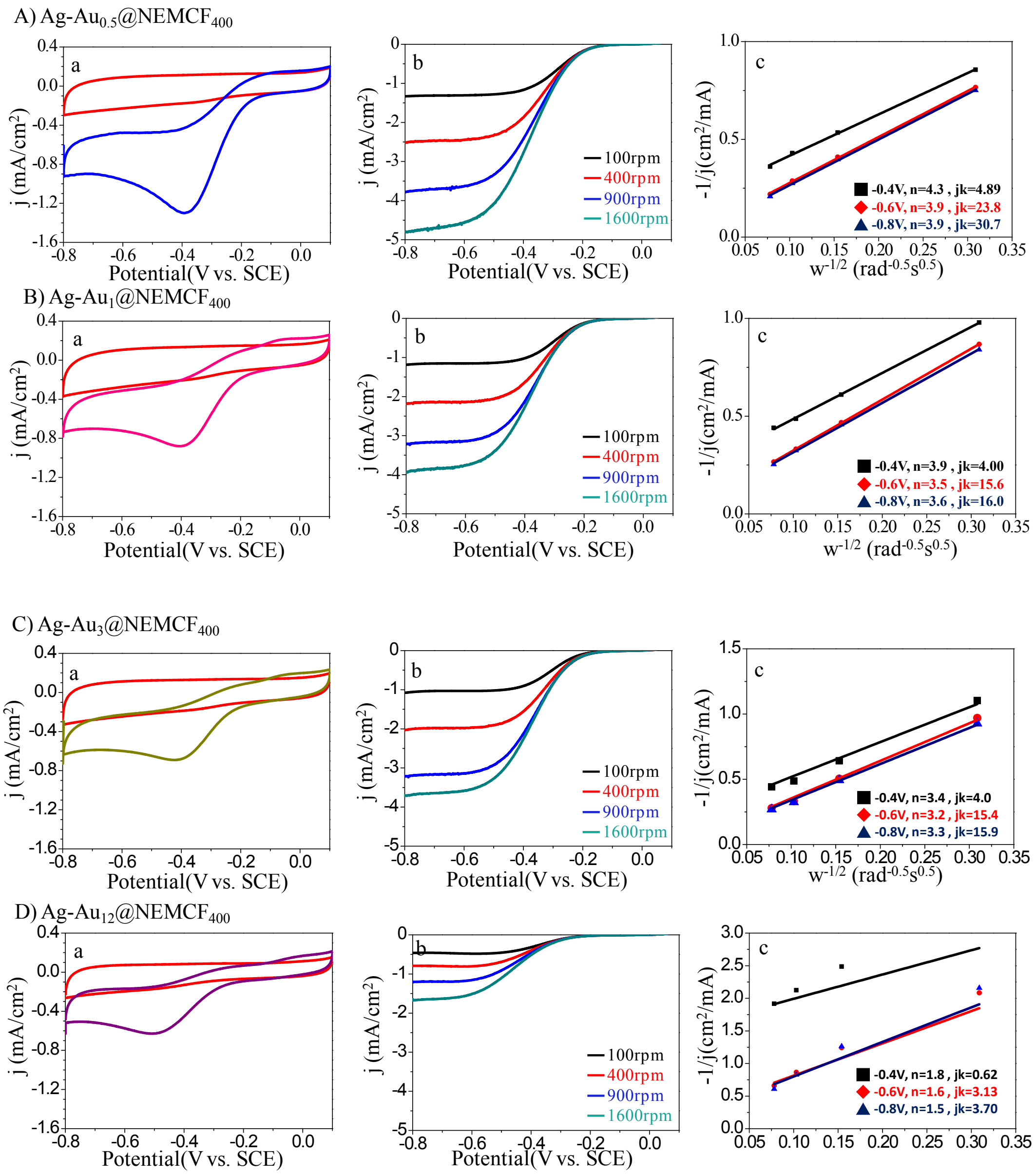

Figure S10 (a) cyclic voltammgram of (A) Ag-$Au_{0.5}$@$NEMCF_{430}$ (B) Ag-Au_1@$NEMCF_{430}$, (C)Ag-Au_3@$NEMCF_{430}$ and (D) Ag-Au_{12}@$NEMCF_{430}$ at a scan rate of 100 mV cm^{-1} in N_2- or O_2-saturated 0.1 M KOH solutions (b) RDE voltammograms recorded for Ag-Au/NEMCF hybrids supported on a GC electrode in an O_2-satutated 0.1 M KOH solution at a scan rate of 10 mV s^{-1} and different rotation rates; (c) K-L plots of j^{-1} vs $w^{-1/2}$ at –0.4, –0.6 and –0.8V obtained from (b).