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Electronic Supporting Information

Pyrolyzed Egg Yolk as an Efficient Bifunctional Electrocatalyst for Oxygen Reduction and Evolution Reactions

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Experimental Details

The morphology of pyrolyzed yolk was observed using scanning (SEM, S-4800, Hitachi) and transmission electron microscopy (TEM, JEM-2100F, JEOL). The crystal structures were analyzed using powder X-ray diffractometry (XRD, D8-Focus, Bruker AXS). The chemical compositions were measured via an X-ray energy-dispersive spectrometer (EDS, NORAN System 6, Thermo Scientific) and X-ray photoelectron spectroscope (XPS, Versa Probe, PHI5000). The graphitic structures was studied by using a micro-Raman spectrometer (DXR, Thermo Scientific) with an incident wavelength of 532 nm.

The electrocatalytic activity towards ORR and OER was measured via an electrochemical workstation (PARSTAT 2273, Princeton) connected with a three-electrode cell, with a Pt sheet as counter electrode, a Ag/AgCl reference electrode and 0.1 M KOH solution as the electrolyte. A thin-film electrode (TFE) method was adopted to prepare the working electrode[1]. Typically, the catalyst ink, obtained by dispersing 5 mg of pyrolyzed yolk into a solution consisting 990 μL of ethanol and 10 μL of 5 wt.% Nafion solution, was applied to the surface of a polished glassy carbon disc and dried at room temperature to obtain a working electrode with a loading of 354 μg catalyst·cm^{-2}. For comparison, TFE with commercial Pt/C catalyst (20 wt.% Pt/C, Johnson Matthey) was also prepared using the same procedure.

In ORR experiment, the TFE was first activated in N_2-saturated electrolyte via cyclic voltammetry (CV) between 0.2 V and -1.2 V (vs. Ag/AgCl). The ORR and OER performance was tested via linear sweep voltammetry (LSV) in O2 and/or N_2 saturated electrolyte with a scan rate of 10 mV·s^{-2}. The catalytic stability under OER condition was tested using chronoamperometry at the potential corresponding to a current density of 10 mA·cm^{-2} at the start.

References

1 R. Kou, Y. Shao, D. Wang, M. H. Engelhard, J. H. Kwak, J. Wang, V. V. Viswanathan, C. Wang, Y. Lin, Y. Wang, Electrochem. Commun. 2009, 11, 954.

Figure S1. HR-TEM images of Yolk-800.

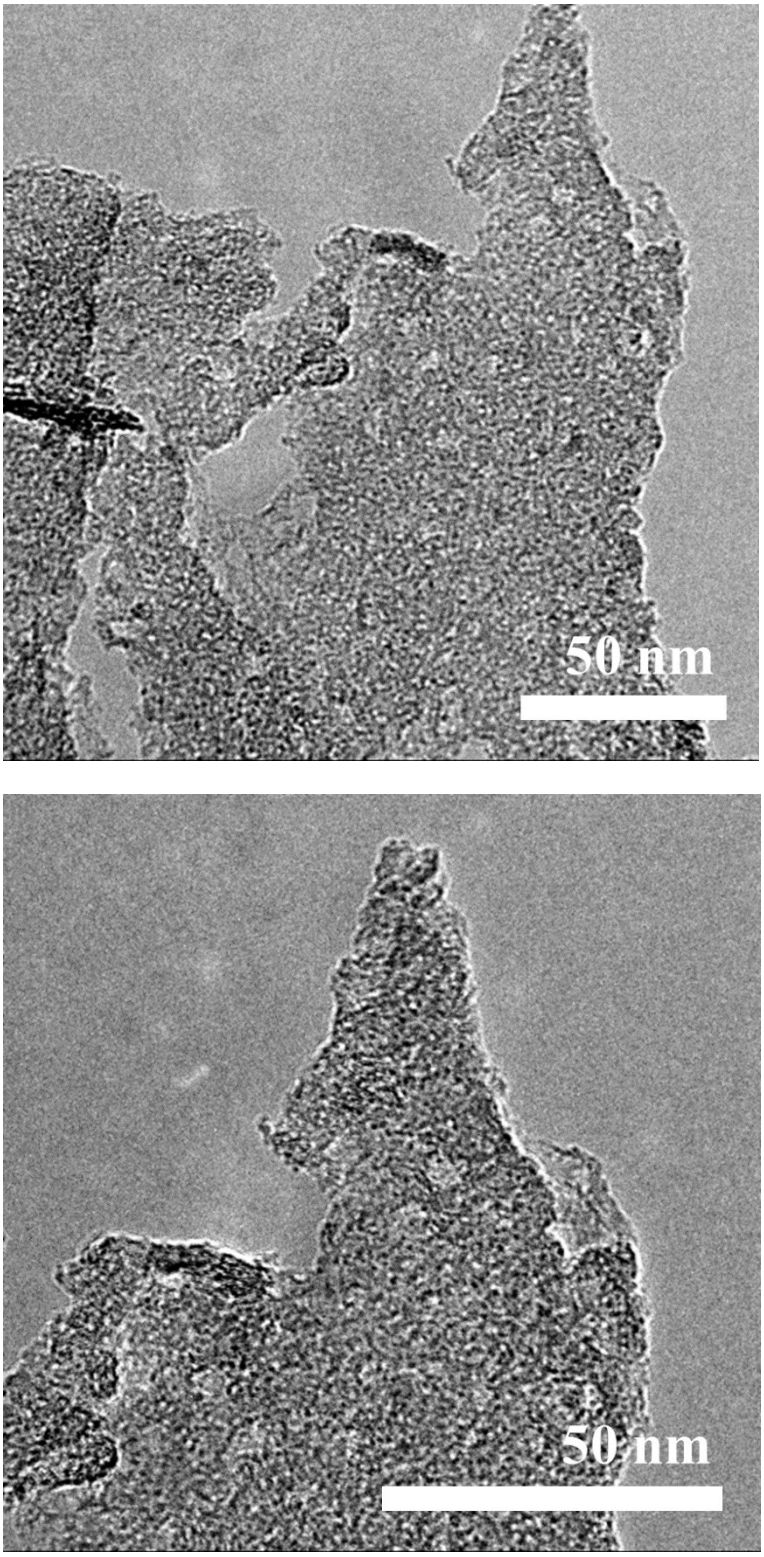

Figure S2. EDS spectra of the catalysts.

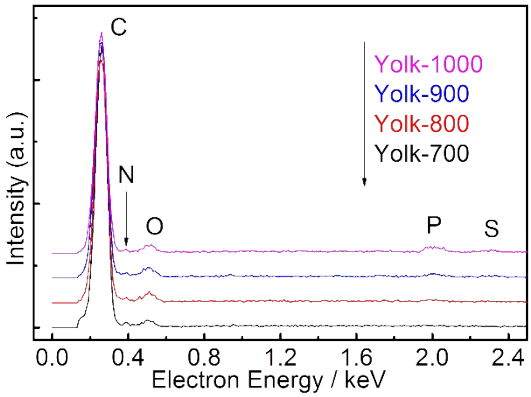

Figure S3. Deconvoluted Raman spectra of Yolk-700 (a), Yolk-900 (b), and Yolk-1000 (c), respectively.

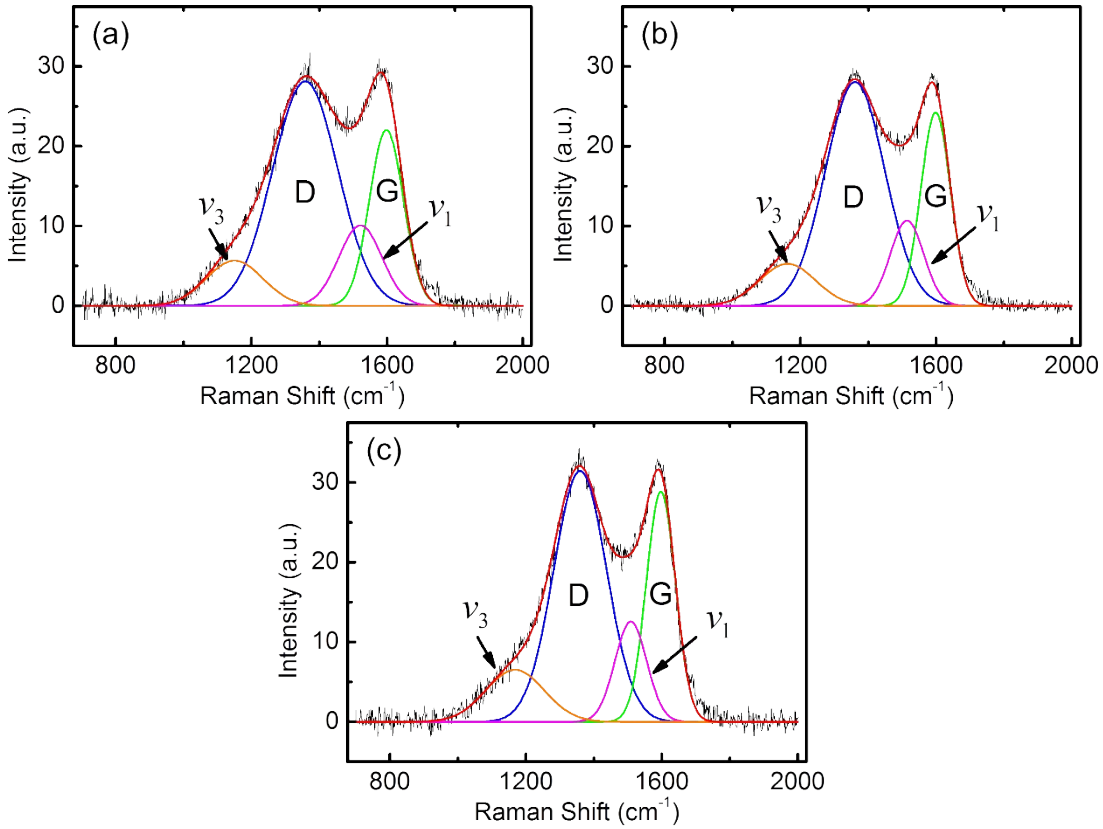

Figure S4. Deconvoluted N1s peaks in XPS spectra of Yolk-700 (a), Yolk-900 (b), and Yolk-1000 (c), respectively.