

Supporting Information

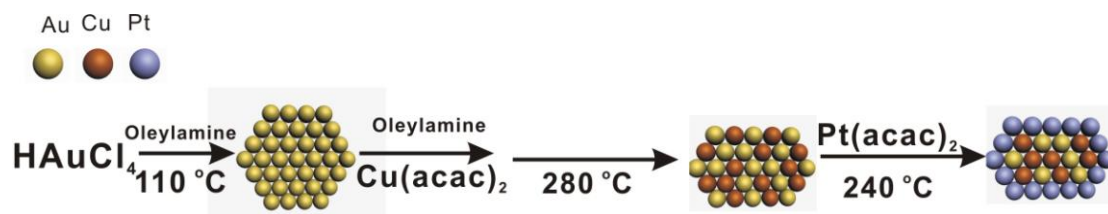
Stabilization and Compressive Strain Effect of AuCu Core on Pt Shell for Oxygen Reduction Reaction

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Synthesis of Pt, AuCu@Pt-2 and AuCu@Pt-3: Besides the commercial Pt/C materials, we have also synthesized Pt nanoparticles from a solution of 65 mg of Pt(acac) in 10 mL of oleylamine, which was heated at 160°C in a nitrogen atmosphere under magnetic stirring for 1 h. For the synthesis of AuCu@Pt-2 and AuCu@Pt-3 nanoparticles, 15 mg and 65 mg of Pt(acac)₂, respectively, were immediately added to the AuCu seed solution, and the mixture was kept at 240°C for 1 h under a nitrogen flow with magnetic stirring. The resulting core-shell nanoparticles were then cooled to room temperature. The nanoparticles in the solution were precipitated by methanol, and washed twice with methanol to remove the free ligands, followed by re-dispersion in hexane. For catalyst loading on Vulcan XC-72 carbon support, 40 mg of carbon was added to the solution of AuCu@Pt-2 or AuCu@Pt-3 nanoparticles. After 24 h of stirring, AuCu@Pt-2/C (with 5 wt% Pt loading) and AuCu@Pt-3/C (with 20 wt% Pt loading) were collected via centrifugation, and washed 3 times with methanol. They were then dried at room temperature in vacuum.



Scheme S1. Seed-mediated growth synthesis of core-shell AuCu@Pt nanoparticles.

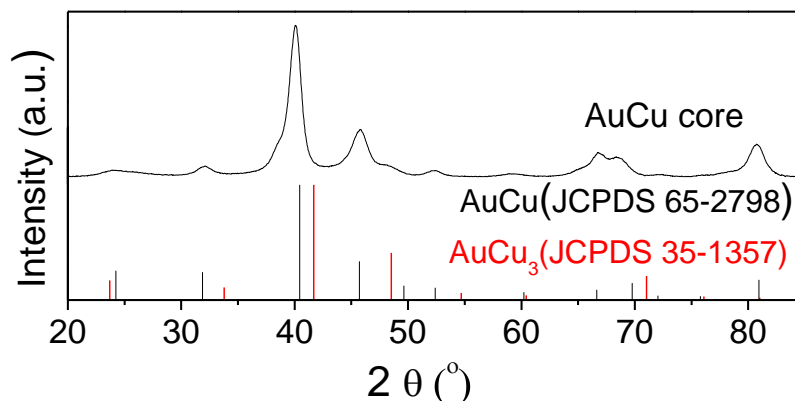


Figure S1. XRD patterns of AuCu reference (JCPDS 65-2798), AuCu₃ reference (JCPDS 35-1357), and AuCu core nanoparticles.

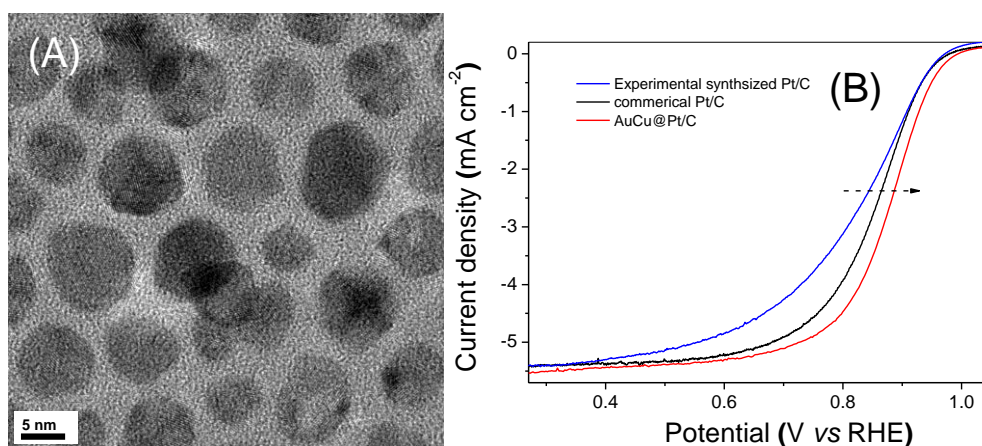


Figure S2. (A) TEM image of Pt nanoparticles synthesized with a fcc structure. (B) Linear sweep voltammograms of the commercial Pt/C, the synthesized Pt/C, and AuCu@Pt/C in oxygen-saturated 0.1 M HClO₄, showing the positive-going scans. Sweep rate = 20 mV/s; room temperature; 1600 rpm.

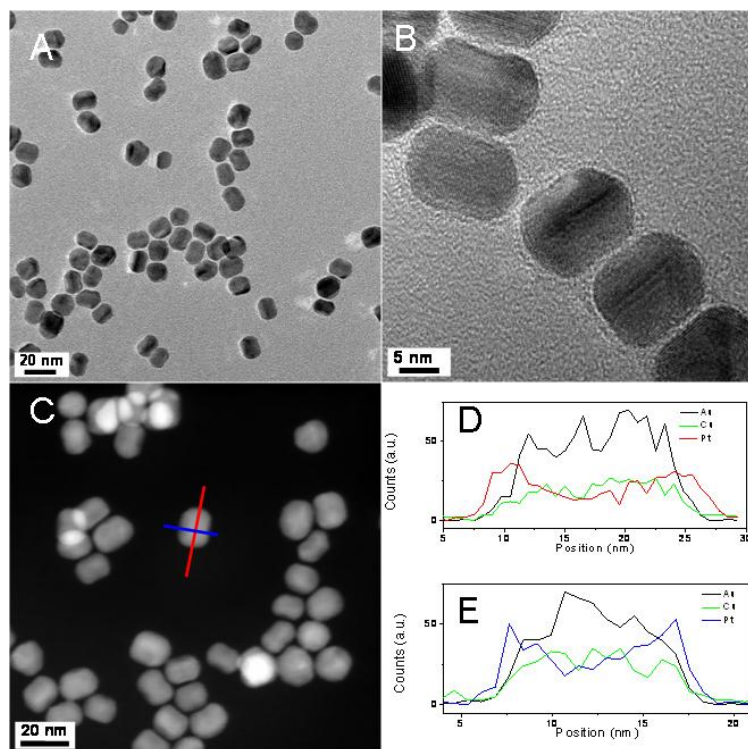


Figure S3. (A) TEM, (B) HRTEM and (C) HAADF-STEM images of AuCu@Pt-2 nanoparticles. Au, Cu and Pt elemental profiles along the (D) red line and (E) blue line across a single nanoparticle shown in (C).

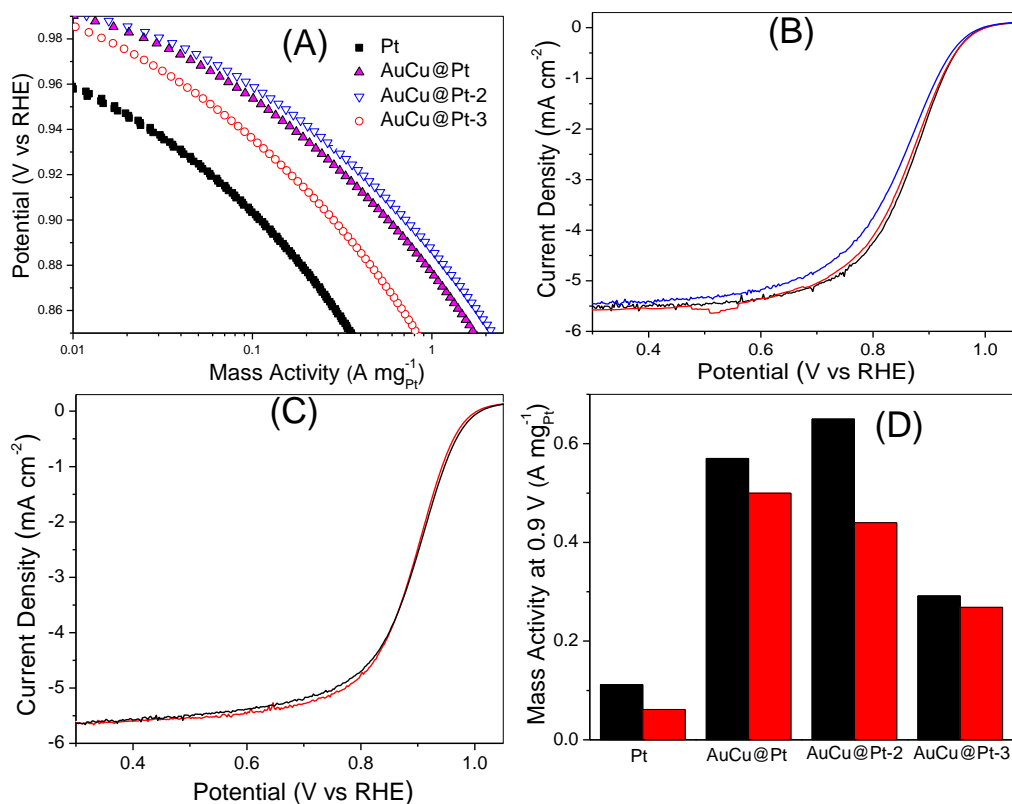


Figure S4. (A) Mass-normalized Tafel regions of ORR over Pt/C, AuCu@Pt/C, AuCu@Pt-2/C and AuCu@Pt-3/C. (B) Linear sweep voltammograms of AuCu@Pt-2/C catalysts in oxygen-saturated 0.1 M HClO₄ before (—), and after (—) 10,000 and (—) 30,000 cycles of stability testing. (C) Linear sweep voltammograms of AuCu@Pt-3/C catalysts before (—) and after (—) 30,000 cycles of stability testing. (D) Kinetic mass activities of ORR over Pt/C, AuCu@Pt/C, AuCu@Pt-2/C and AuCu@Pt-3/C before (■) and after (■) 30,000 cycles of stability testing.

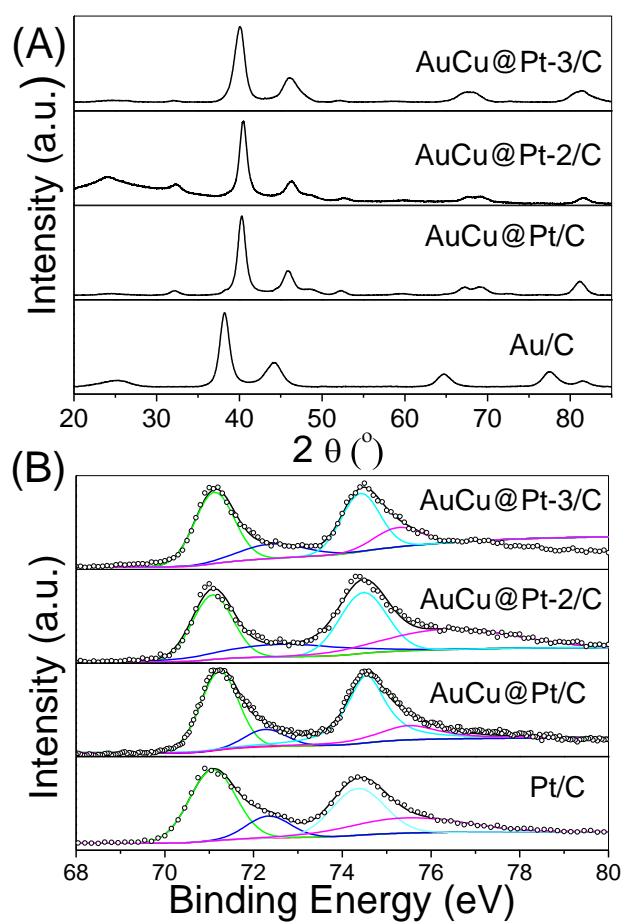


Figure S5. (A) XRD patterns of Au/C, AuCu@Pt/C, AuCu@Pt-2/C and AuCu@Pt-3/C. (B) XPS spectra of Pt/C, AuCu@Pt/C, AuCu@Pt-2/C and AuCu@Pt-3/C.

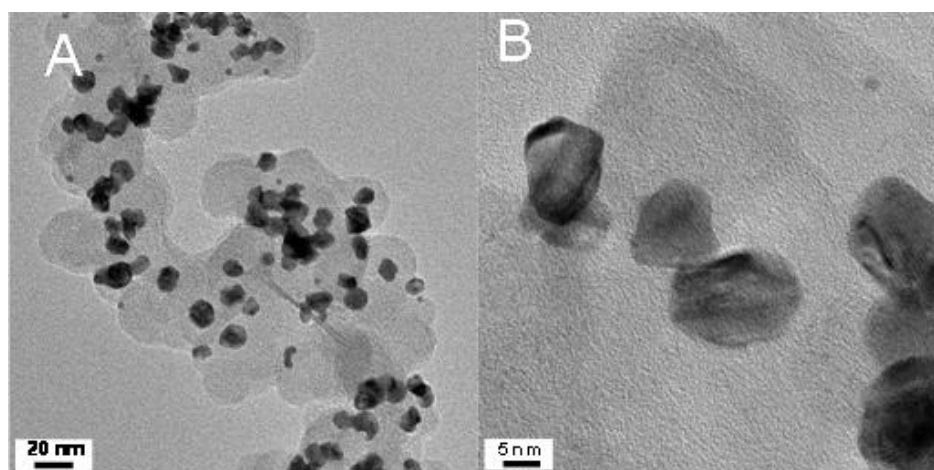


Figure S6. (A) TEM and (B) HRTEM images of AuCu@Pt-2 nanoparticles supported on XC-72 carbon after 30,000 cycles of stability testing.

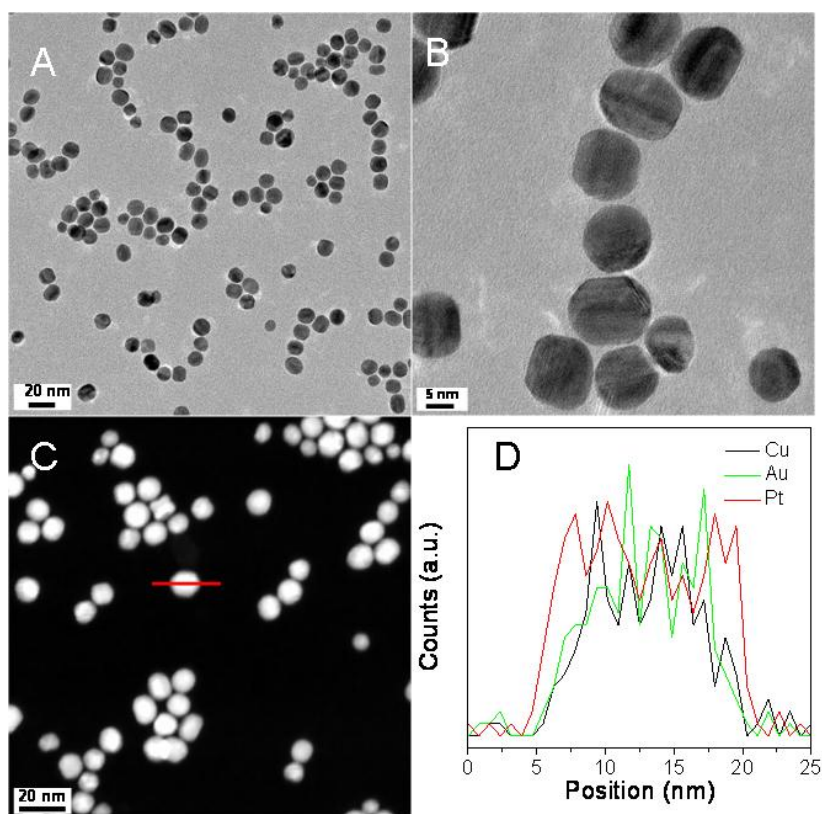


Figure S7. (A) TEM, (B) HRTEM and (C) HAADF-STEM images of AuCu@Pt-3 nanoparticles. (D) Cu, Au and Pt elemental profiles along the red line across a single nanoparticle shown in (C).

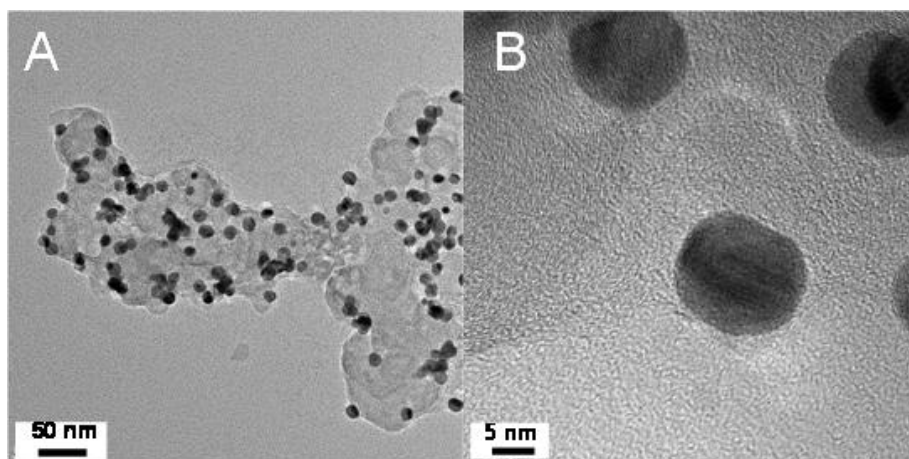


Figure S8. (A) TEM and (B) HRTEM images of AuCu@Pt-3 nanoparticles supported on XC-72 carbon after 30,000 cycles of stability testing.