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Mesoporous AuAgCu Alloys with Tuned Defects and Composition for Enhanced Electrochemical Sensing

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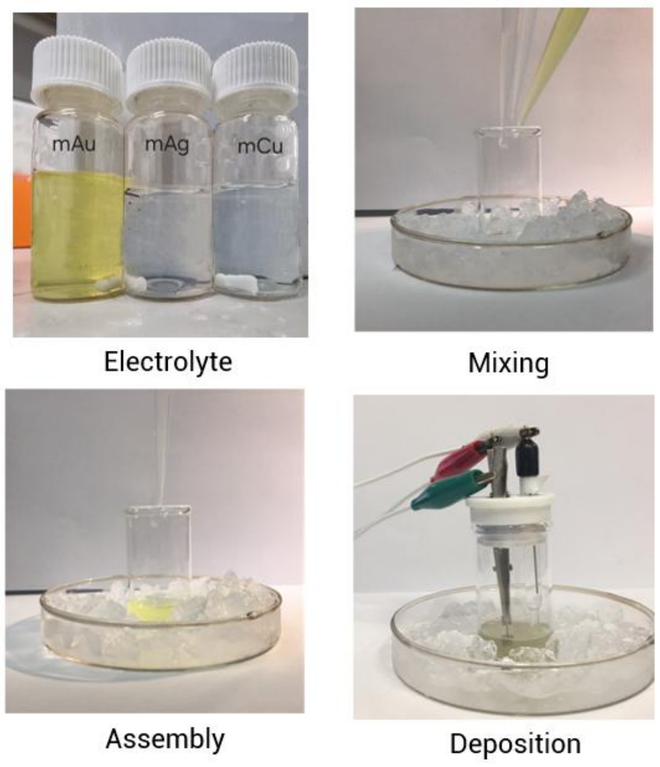
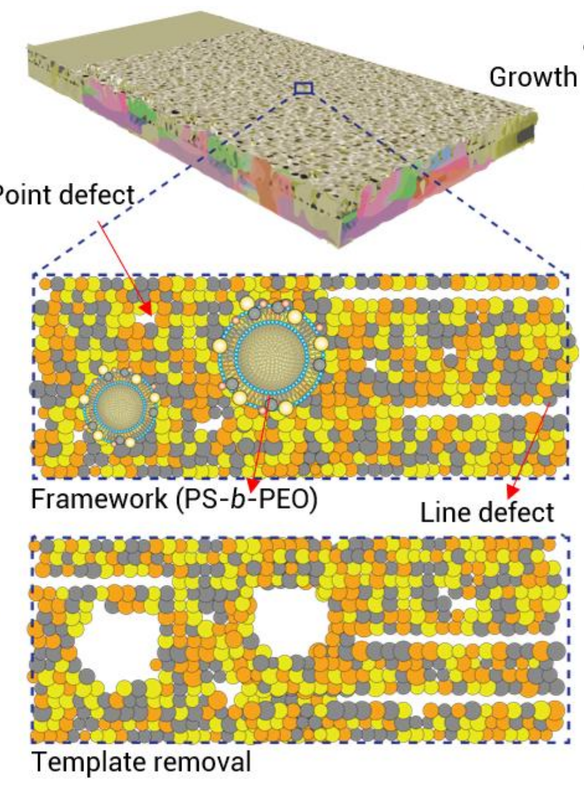
INTRODUCTION & AIM

Electrochemical sensors demand electrodes with high surface area and defect control. Mesoporous Au–Ag–Cu alloys on amorphous glass substrates overcome the limits of mono/bimetallic films. The smaller Cu atoms induce compressive strain and uniform defects, yielding optimized $mAu_{0.6}Ag_{0.2}Cu_{0.2}$films with uniform mesopores, high ECSA, and stable activity. This work demonstrates how composition and strain/defect engineering enable enzyme-free, high-performance sensing.



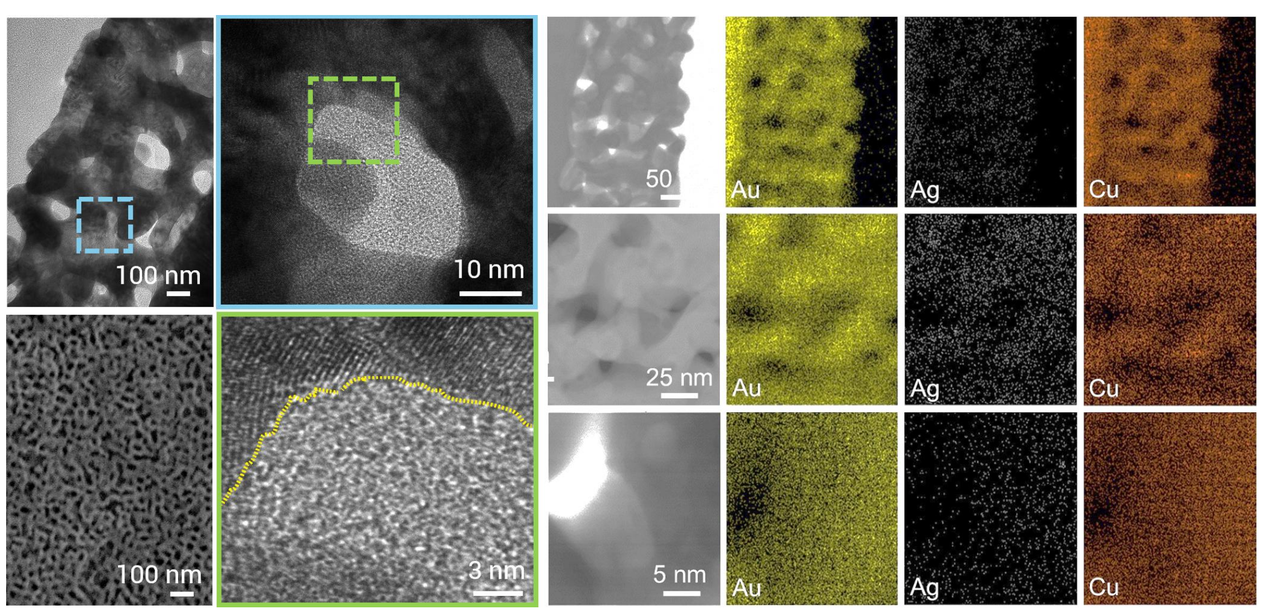


Soft-templated electrodeposition of mesoporous Au–Ag–Cu

METHOD

1. Soft-templating: PS–PEO micelles
2. Electrodeposition: −0.7 V, 600 s (Au/Ag/Cu salts)
3. Post-treatment: THF rinse
4. Characterization: SEM/TEM/XRD/XPS, CV/DPV/i–t

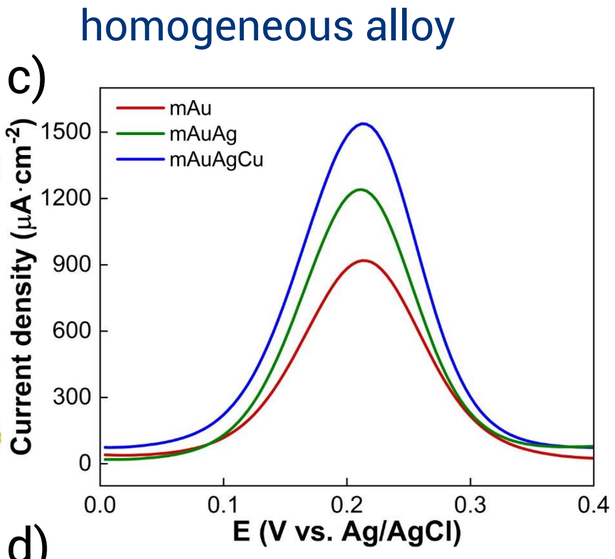
RESULTS & DISCUSSION

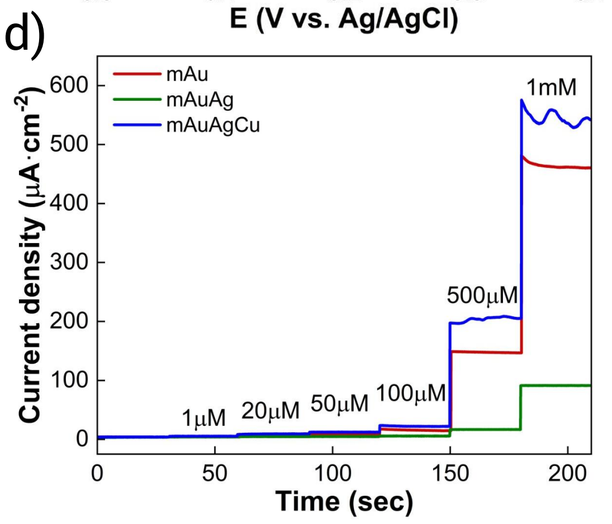


Structural and compositional characterization of mesoporous Au–Ag–Cu: Uniform ~22 nm mesopores (SEM/TEM), defects & lattice strain (HRTEM), and homogeneous Au–Ag–Cu distribution (STEM-EDS).

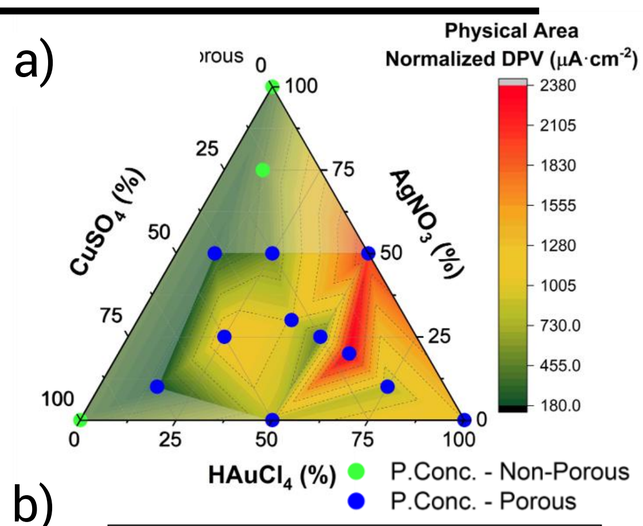
Structure & defects

- Uniform ~22 nm pores
- ~5% (200) d-spacing reduction → compressive strain
- Twins/dislocations confirmed (FFT/SAED)
- STEM–EDS: homogeneous alloy





(c) Area-normalized DPV response in $[Fe(CN)_6]^{3-/4-}$
(d) Chronoamperometric glucose sensing.



(a) Ternary compositional map with normalized DPV,
(b) CV stability after 30 cycles in $[Fe(CN)_6]^{3-/4-}$.

Electrochemistry

- ECSA: 1051 vs Au (844), AuAg (584) $\mu A \cdot cm^{-2}$

Glucose sensing

- LOD (intercept-corrected): 40 μM vs Au (104), AuAg (447)
- No amplification, photopatterning, or covalent functionalization

CONCLUSION

- Balanced porosity, strain/defect control, stable activity
- Atomic-level tuning unlocks enzyme-free, sensitive sensing
- Promising for practical biosensing/diagnostics

FUTURE WORK / REFERENCES

- Modified electrode coatings as smart, adaptive, logic-based platforms for reversible protein sensing in post-diagnostic monitoring.

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Park et al., *ACS Nano*, 2025, DOI: 10.1021/acsnano.4c11730
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