Electronic Supplementary Material (ESI) for New Journal of Chemistry.

Supplementary Information

Facile Fabrication of Bimetallic Cu-Ag Binary hybrid Nanopaticles and their application in Catalysis

Yuxi Meng[a], Hanyu Gao[a], Shuang Li[a], Fang Chai[*ab], Lihua Chen[*b]

[a] Key Laboratory of Photochemical Biomaterials and Energy Storage Materials, Heilongjiang Province; Key Laboratory for Photonic and Electronic Bandgap Materials, Ministry of Education, Harbin, 150025, Heilongjiang, China.

* Corresponding author. E-mail: fangchai@gmail.com

[b] Shandong Key Laboratory of Biochemical Analysis; College of Chemistry and Molecular Engineering, Qingdao University of Science and Technology, Qingdao 266042, PR China.

E-mail: Lihuachen@qust.edu.cn

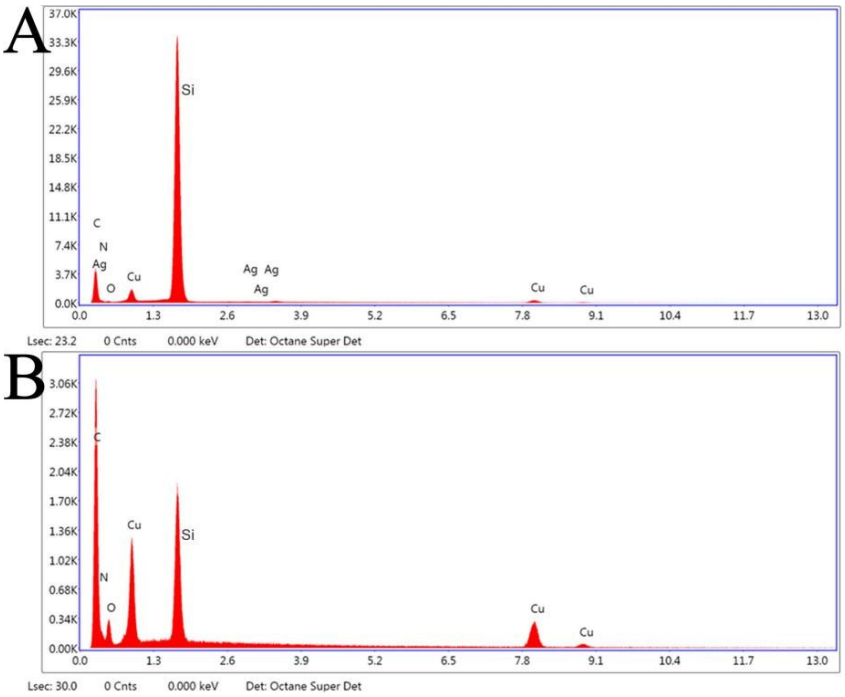

Fig. S1. EDS spectrum of (A) Trp-Cu-Ag NPs (B) Trp-Cu NPs. Both of the two sample were gained at 120 °C, 6 h.

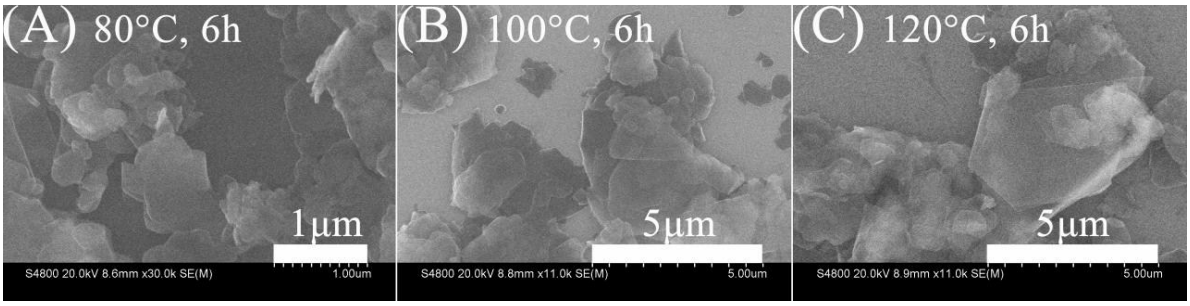

Fig. S2. SEM image of Trp-Cu NPs at different reaction condition: (A) 80 °C, 6 h; (B) 100 °C, 6 h; (C) 120 °C, 6 h.

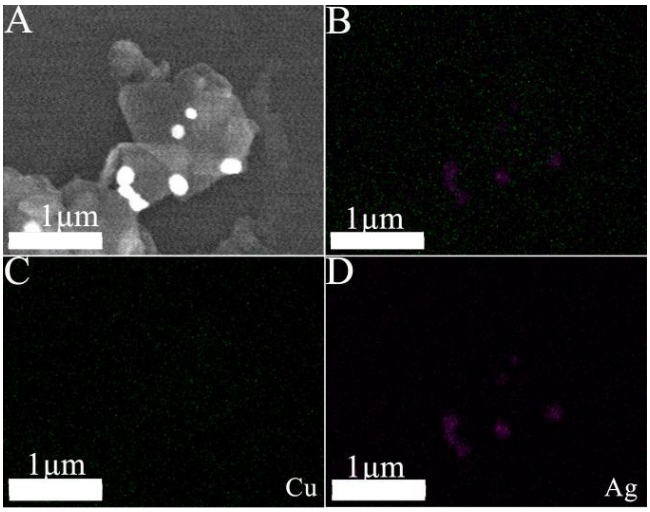

Fig. S3. Elemental mappings showing the spatial distribution of Cu (C, green), and Ag (D, pink) in a part of Trp-Cu-Ag NPs.

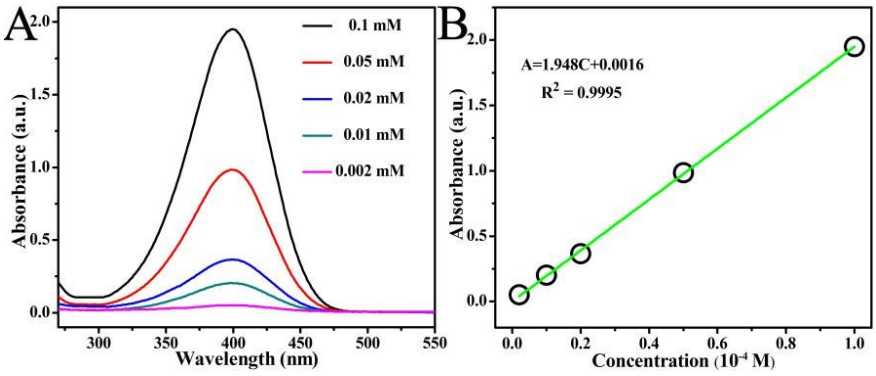

Fig. S4. Absorption spectra of aqueous mixture solutions of 4-NP and $NaBH_4$ at different concentrations of 4-NP. (b) Plot of the peak absorbance against the concentration of 4-NP.

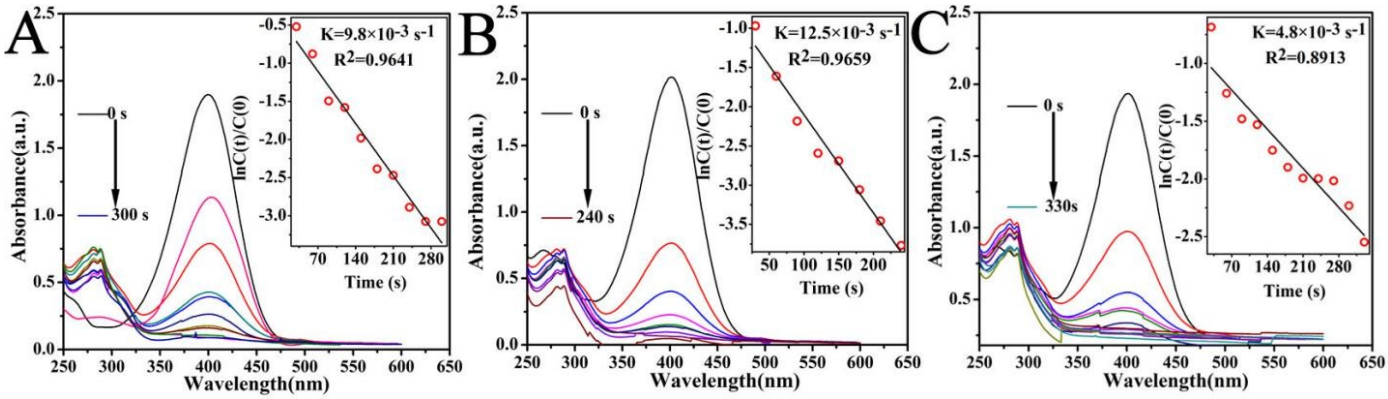

Fig. S5. UV-vis absorption spectra of reduction of 4-NP by $NaBH_4$ under the catalysis of Trp-Cu NPs reacted at various condition: (A) 80 °C, 6 h; (B) 100 °C, 6 h; (C); (D) 120 °C, 6 h. (Insets: the corresponding $\ln(C_{(t)}/C_{(0)})$ versus reaction time for reduction of 4-NP).

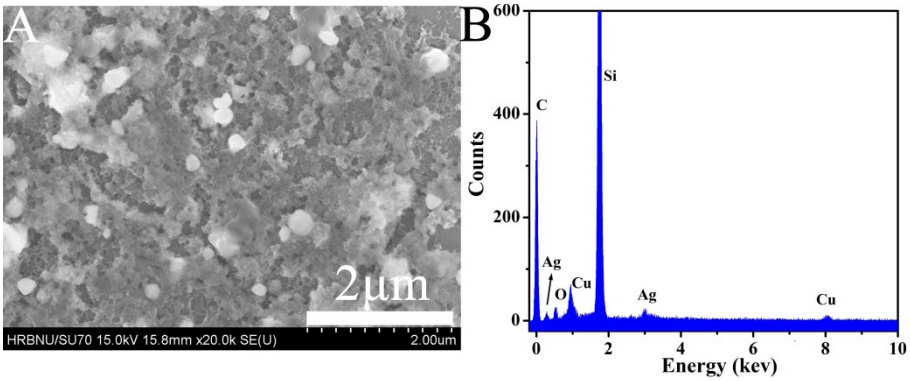

Fig. S6. (A) SEM image of Trp-Cu-Ag NPs after catalytic reduction of 4-NP for multiple (10) times circularly and (B) the corresponding EDS spectrum.

Table S1. React time and rate constant of reduction of 4-NP by $NaBH_4$ under the catalysis of Trp-Cu-Ag NPs reacted at various condition: (A) 80 °C, 2 h; (B) 80 °C, 4 h; (C) 80 °C, 6 h; (D) 100 °C, 2 h; (E) 100 °C, 4 h; (F) 100 °C, 6 h; (G) 120 °C, 2 h; (H) 120 °C, 4 h; (I) 120 °C, 6 h.

Sample		React time (t)	Rate constant (k)
80 °C	2 h	300 s	14.5×10^{-3} s^{-1}
80 °C	4 h	180 s	21.1×10^{-3} s^{-1}
80 °C	6 h	270 s	15.4×10^{-3} s^{-1}
100 °C	2 h	510 s	5.1×10^{-3} s^{-1}
100 °C	4 h	150 s	27.4×10^{-3} s^{-1}
100 °C	6 h	150 s	33.9×10^{-3} s^{-1}
120 °C	2 h	90 s	37.9×10^{-3} s^{-1}
120 °C	4 h	390 s	8.7×10^{-3} s^{-1}
120 °C	6 h	330 s	13.0×10^{-3} s^{-1}

Table S2. Comparison of pseudo-first-order rate constants for 4-NP reduction by metal nanometerials containing Trp-Cu-Ag NPs.

Materials	Concentration of 4-NP	Amount of catalyst	K_{app}	References
Trp-Cu-Ag NPs	0.01 M	2 mg/mL	37.9×10^{-3} s^{-1}	This work
highly branched Pt@Ag NPs	1×10^{-4} M	1 mg/mL	5.9×10^{-3} s^{-1}	[1]
PCP@Au-Ag composites	2×10^{-4} M	1 mg/mL	2.87×10^{-3} s^{-1}	[2]
PdNiP/RGO	5×10^{-3} M	1 mg/mL	23.5×10^{-3} s^{-1}	[3]
CeO_2@Au@CeO_2 -MnO_2	3×10^{-7} M	5 mg/mL	3.2×10^{-3} s^{-1}	[4]
Fe-Fe_2O_3@PDA NCs	2×10^{-4} M	0.1 mg/mL	15×10^{-3} s^{-1}	[5]
bio-Pd/Au-NPs	1.08×10^{-3} M	8.3 mg/mL	2.8×10^{-3} s^{-1}	[6]

References

[1] Z. Lv, X. Zhu, H. Meng, J. Feng and A. Wang. *J. Colloid Interf. Sci.* 2019, **538**, 349.

[2] J. Fu, S. Wang, J. Zhu, K. Wang, M. Gao, X. Wang and Q. Xu. *Mater. Chem. Phys.* 2018, **207**, 315.

[3] X. Gao, H. Zhao, Y. Liu, Z. Ren, C. Lin, J. Tao and Y. Zhai. *Mater. Chem. Phys.* 2019, **222**, 391.

[4] G. Chen, Y. Wang, Y. Wei, W. Zhao, D. Gao, H. Yang and C. Li. *ACS Appl. Mater. Interfaces* 2018, **10**, 11595.

[5] S. Wang, J. Fu, K. Wang, M. Gao, X. Wang, Z. Wang, J. Chen and Q. Xu. *Appl. Surf. Sci.* 2018, **459**, 208.

[6] H. Zhang and X. Hu. *Enzyme Microb. Tech.* 2018, **113,** 59.