Electronic Supplementary Information

# A simple and effective method for controllable synthesis of silver and silver oxide colloidal nanocrystals

Jacqueline E. Cloud, [a] Lauren W. Taylor, [a] and Yongan Yang[a]*
[a]Department of Chemistry and Geochemistry, Colorado School of Mines, 1500 Illinois Street, Golden CO, USA

**Table S1**. Standard reduction potentials of the elements studied by AVIES.[1, 2]

| Metal | Reaction | $E^o$ vs. $E^oH^+/H_2$ | Products |
|---|---|---|---|
| Au | $Au^{3+} + 3e^- \rightleftharpoons Au^0$<br>$Au^+ + e^- \rightleftharpoons Au^0$ | 1.50<br>1.41 | $Au^0$ NCs |
| Pt | $Pt^{2+} + 2e^- \rightleftharpoons Pt^0$<br>$PtO_2 + 4H^+ + 4e^- \rightleftharpoons Pt^0 + 2H_2O$ | 1.18<br>0.92 | $Pt^0$ NCs |
| Pd | $Pd^{2+} + 2e^- \rightleftharpoons Pd^0$<br>$PdO + 2H^+ + 2e^- \rightleftharpoons Pd^0 + H_2O$ | 0.915<br>0.79 | $Pd^0$ NCs |
| **Ag** | **$Ag^+ + e^- \rightleftharpoons Ag^0$**<br>**$Ag_2O + H_2O + 2e^- \rightleftharpoons 2Ag^0 + 2OH^-$** | **0.799**<br>**0.342** | **$Ag^0$ NCs**<br>**$Ag_2O$ NCs** |
| Cu | $Cu^{2+} + 2e^- \rightleftharpoons Cu^0$<br>$Cu_2O + H_2O + 2e^- \rightleftharpoons 2Cu^0 + 2OH^-$ | 0.340<br>-0.530 | $Cu_2O$ NCs |
| Sn | $Sn^{2+} + 2e^- \rightleftharpoons Sn^0$<br>$SnO_2 + 4H^+ + 4e^- \rightleftharpoons Sn^0 + 2H_2O$ | -0.141<br>-0.118 | Sn NCs |
| Ni | $Ni^{2+} + 2e^- \rightleftharpoons Ni^0$<br>$Ni(OH)_2 + 2e^- \rightleftharpoons Ni^0 + 2OH^-$<br>$NiO + H_2O + 2e^- \rightleftharpoons Ni^0 + 2OH^-$ | -0.236<br>-0.714<br>-0.686 | NiO NCs and Ni(OH) NCs |
| Cd | $Cd^{2+} + 2e^- \rightleftharpoons Cd^0$<br>$CdO + H_2O + 2e^- \rightleftharpoons Cd^0 + 2OH^-$ | -0.4025<br>-0.8232 | CdO NCs |
| Zn | $Zn^{2+} + 2e^- \rightleftharpoons Zn^0$<br>$ZnO + H_2O + 2e^- \rightleftharpoons Zn^0 + 2OH^-$ | -0.762<br>-1.590 | ZnO NCs |
| Ti | $Ti^{2+} + 2e^- \rightleftharpoons Ti^0$<br>$TiO_2 + 4H^+ + 4e^- \rightleftharpoons Ti^0 + 2H_2O$ | -1.60<br>-1.076 | $TiO_2$ NCs |

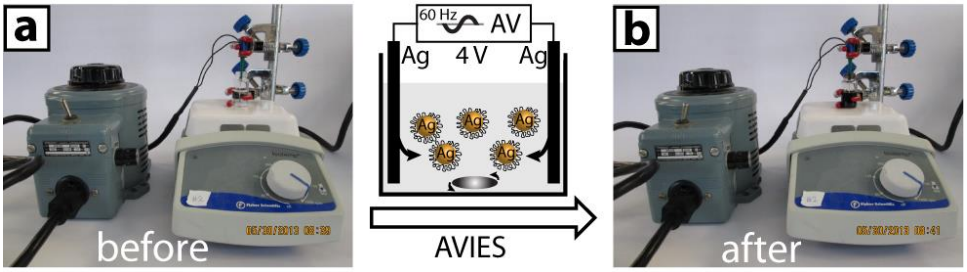


**Fig. S1** Illustration of the AVIES method for synthesizing Ag-based NCs: before (a) and after (b) the reaction.

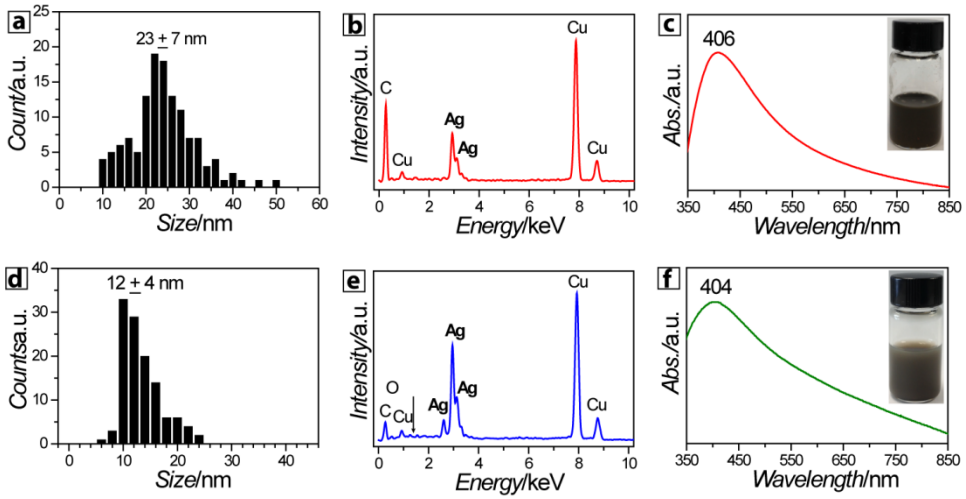


**Fig. S2** (a) Histogram showing the size distribution of Ag nanocrystals shown in Fig. 1(d) (NaBr, no stirring); (b) EDX of Ag nanocrystals shown in Fig. 1(d); (c) UV-Vis absorption spectrum of Ag nanocrystals in Fig. 1(d); (d) Histogram showing the size distribution of Ag-$Ag_2O$ nanocrystals in Fig. 1(f) ($KNO_3$, no stirring); (e) EDX of Ag-$Ag_2O$ nanocrystals in Fig. 1(f); and (f) UV-Vis absorption spectrum of Ag-$Ag_2O$ nanocrystals in Fig. 1(f).

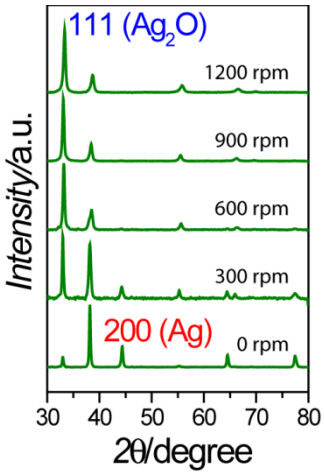


**Fig. S3** XRD profiles of the products obtained from $KNO_3$ solutions by using different stirring rates of 0 – 1200 rpm.

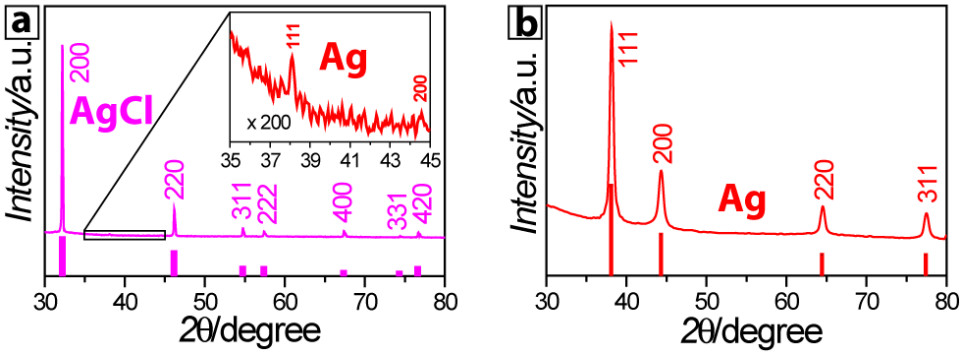


**Fig. S4** XRD profiles of the products obtained from KCl (a) and NaBr (b) solutions by using the stirring rate of 1200 rpm.

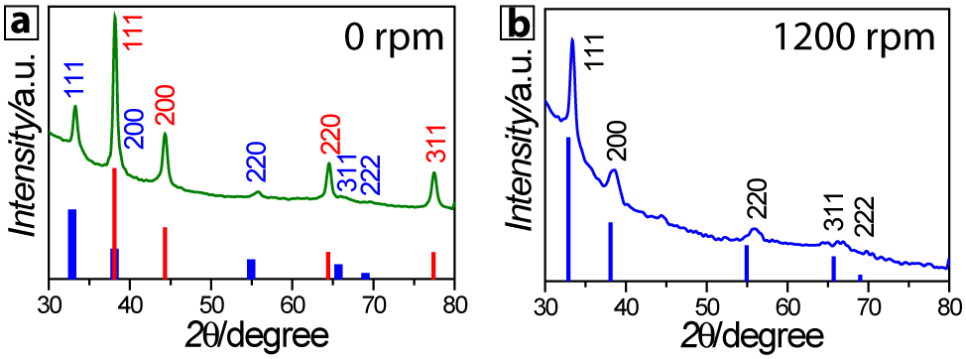


**Fig. S5** XRD profiles of the obtained Ag-$Ag_2O$ nanocrystals (a) and $Ag_2O$ nanocrystals (b) from $K_2SO_4$ solutions, by using different stirring rates of 0 rpm (a) and 1200 rpm (b), respectively.

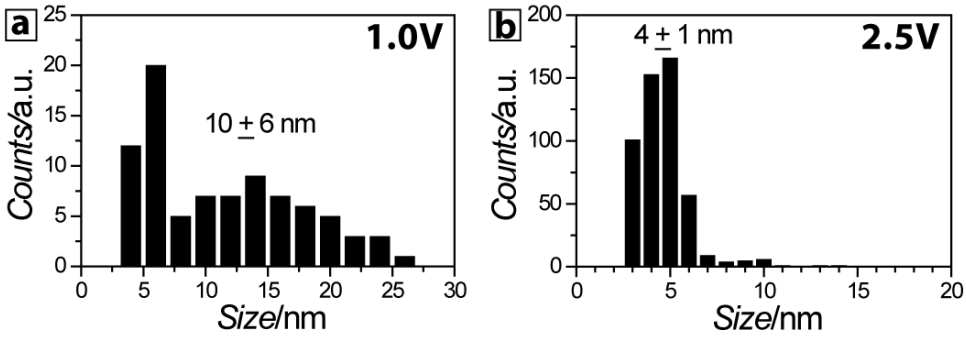


**Fig. S6** Histograms of the nanocrystals shown in Fig. 4(b) (a) and Fig. 4(d) (b), of which the voltages are 1.0 V and 2.5 V, respectively.

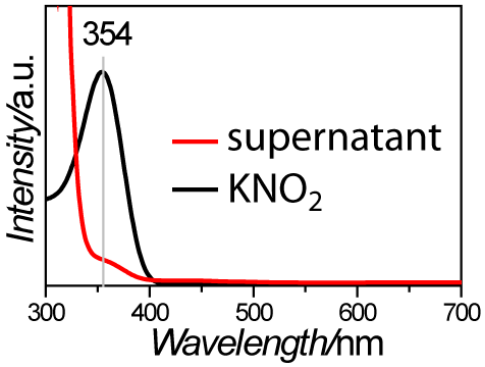


**Fig. S7** UV-Vis absorption spectra of the supernatant of the $KNO_3$ reaction solution using 4.0 V (red) and a standard $KNO_2$ solution (black).

## References

1. D. C. Harris, *Quantitative Chemical Analysis*, W.H. Freeman, New York, 8th edn., 2010.
2. A. J. Bard and L. R. Faulkner, *Electrochemical methods: fundamentals and applications*, John Wiley and Sons Inc., 2nd edn., 2001.