Chemical Colorimetric Square Wave and its Derived Logic Gates Based on Tunable Growth of Plasmonic Gold Nanoparticles

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Figure S1. (A) The UV-Vis spectra of AuNPs solutions with different H$_2$O$_2$ concentrations. (B) Variation of the values of $A_{550/650}$ with time after adding different concentrations of H$_2$O$_2$ to the gold precursor solution.
**Figure S2.** The TEM measurements performed to investigate the state of AuNPs obtained with different concentrations of H$_2$O$_2$. TEM images of AuNPs grown in the presence of (A) 60 µM H$_2$O$_2$ and (B) 80 µM H$_2$O$_2$. 
Figure S3. DLS analysis of AuNPs grown in the presence of HAuCl₄ (0.1 mM), 60 µM H₂O₂ or 80 µM H₂O₂.
Figure S4. The TEM images of AuNPs obtained with or without AgNO₃. The reaction conditions: (A) H₂O₂ (60 µM) and HAuCl₄ (0.1 mM) in MES buffer (1 mM, pH 6.5); (B) H₂O₂ (60 µM), HAuCl₄ (0.1 mM) and AgNO₃ (1 µM) in MES buffer (1 mM, pH 6.5).
**Figure S5.** Variation of $A_{550/650}$ of solutions with time obtained under different reaction conditions: AgNO$_3$: AgNO$_3$ (1 µM), H$_2$O$_2$ (60 µM) and HAuCl$_4$ (0.1 mM); Blank: the control without AgNO$_3$; C1: the control without H$_2$O$_2$; C2: the control without HAuCl$_4$; NaNO$_3$: the control using NaNO$_3$ (1 µM) instead of AgNO$_3$. 
Figure S6. The UV-Vis spectra of AuNPs with 60 µM H₂O₂ and different concentrations of AgNO₃ (0 ~5 µM): (A) the first OFF interval of the Ag⁺-CCSW (0 ~ 100 nM); (B) ON interval of the Ag⁺-CCSW (100 nM ~ 1 µM); (C) the second OFF interval of the Ag⁺-CCSW (1 µM ~ 5 µM).
Figure S7. DLS analysis of AuNPs grown in the presence of HAuCl₄ (0.1 mM), 60 μM H₂O₂ and different concentrations of AgNO₃.
Figure S8. EDX analysis of AuNPs grown in the presence of different concentrations of AgNO₃ (A: 0.075 µM, B: 1 µM and C: 5 µM) with HAuCl₄ (0.1 mM) and H₂O₂ (60 µM).
Figure S9. The variation of $A_{550/650}$ of solutions with time obtained under different concentrations of Ag$^+$. The AuNPs formed under the following conditions: H$_2$O$_2$ (60 µM), HAuCl$_4$ (0.1 mM) and different concentrations of Ag$^+$ (0 ~ 5 µM) in MES buffer (50 mM, pH 6.5). Only the solutions with the concentration of AgNO$_3$ located in the ON interval of the Ag$^+$-CCSW (100 ~ 1000 nM) would lead to the $A_{550/650}$ surpassing 2, otherwise the $A_{550/650}$ below 2 was obtained with Ag$^+$ concentration within the first OFF interval (0 ~ 100 nM) or the second OFF interval (1 µM ~ 5 µM).
Figure S10. The selectivity of the metal ions for assisting the growth of AuNPs and constructing the CCSW. (A) Different color and (B) the absorption ratio value ($A_{550/650}$) of AuNPs solution obtained with 60 µM H$_2$O$_2$ and in the presence of 1 µM Ag$^+$ and 1 µM other metal ions, respectively.
**Figure S11.** The UV-Vis spectra of AuNPs with 60 µM H_{2}O_{2} and 1 µM of AgNO_{3} in MES buffer with different pH (pH 3.2 ~ 8.5): (A) the first OFF interval of the pH-CCSW (3.2 ~ 5.0); (B) ON interval of the pH-CCSW (5.5 ~ 6.5); (C) the second OFF interval of the pH-CCSW (7.0 ~ 8.5).
Figure S12. The variation of $A_{550/650}$ of solutions with time obtained at different pH. The AuNPs formed under the following condition: $\text{H}_2\text{O}_2$ (60 µM), HAuCl$_4$ (0.1 mM) and Ag$^+$ (1 µM) in MES buffer with different pH (50 mM, pH 3.2 ~ 8.5). Only the solutions with the pH located in the ON interval of pH-CCSW (pH 5.5 ~ 6.5) would lead to the $A_{550/650}$ surpassing 2, otherwise the $A_{550/650}$ below 2 was obtained with the pH within the first OFF interval (3.2 ~ 5.0) or the second OFF interval (7.0 ~ 8.5).
Figure S13. DLS analysis of AuNPs grown in the presence of HAuCl₄ (0.1 mM), 60 μM H₂O₂ in MES buffer with different pH values.