Supporting Information

Colorimetric Determination of Hydrogen Peroxide by Morphological Decomposition of Ag Nanoprisms Coupled With Chromaticity Analysis

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Figure S1. Normalized UV-visible spectra of red-AgNPrs for three repetitions.
Figure S2. The influences of (A) pH and (B) temperature on the AgNPrs with the insets of AgNPr solution color at various pH and temperatures.

The effect of pH and temperature on the synthesized of AgNPrs was monitored by using UV-visible spectroscopy. A pH of AgNPr solution was adjusted to pH 3-10 using either 20% acetic acid or 10% NH₄OH. A temperature of AgNPr solution was adjusted in the range of 28°C – 90°C using water bath. The Δλ of AgNPrs and corresponding solution color at various pH and temperature are depicted in Figure 1A and 1B, respectively. The results reveal that no significant changes in LSPR of AgNPrs (Δλ = 0) in the range of pH 3-8. In addition, no considerable changes in LSPR of AgNPrs is observed in the temperature range of 28-40°C. The Δλ increase and the color of the AgNPr solution became pale orange only when pH > 9 or temperature > 45 ºC.
To gain an insight into understanding the decomposition profile and the evaluation of the optical characteristics of the AgNPr solution as a LSPR-based hydrogen peroxide sensor, 100 µM of H₂O₂ was introduced to 10 ppm of AgNPr solution in a quartz cuvette. The time-resolved LSPR band of AgNPrs incubated with the imposed H₂O₂ from 0 to 15 min was monitored by UV-visible spectroscopy (Figure S1). The in-plane dipole LSPR of AgNPrs (λ_max = 502 nm) gradually blue-shifted after the addition of H₂O₂, while the out-of-plane quadrupole LSPR (λ_max = 340 nm) remained unchanged. These results indicate that the lateral size of AgNPr decreased, while the aspect ratio of the morphology remained the same, i.e. the thickness of AgNPr constantly decreased along with the lateral size.

Figure S3. (A) Time-resolved LSPR spectra of AgNPrs after addition of 100 µM H₂O₂ from 0 to 15 min of incubation time. (B) Variations of absorbance and peak position of the in-plane dipole LSPR with incubation time. (C) Variations of absorbance and peak position of the out-of-plane quadrupole LSPR with incubation time.
Figure S4. Extinction spectra of the original red-AgNPrs, red-AgNPrs interacting with hydrogen peroxide, and the solution after the conversion of silver ions to silver nanospheres by the addition of a reducing agent (NaBH₄).

The original AgNP solution employed in the study exhibited the red-wine color with an in-plane dipole LSPR peak centered at 504 nm. The complete degradation of AgNPrs was observed when a high concentration of H₂O₂ (1000 µM) was introduced. From inset of Figure S3, it can be seen that the solution color changed from red to colorless. This observation confirms the etching phenomenon on AgNPrs after interacting with H₂O₂ as expressed by the following chemical equations [1-5]:

\[
\begin{align*}
    \text{Ag}^+ + e^- & \rightarrow \text{Ag} \quad E^0 = 0.7996 \text{ V} \\
    \text{H}_2\text{O}_2 + 2e^- & \rightarrow 2\text{HO}^- \quad E^0 = 0.8670 \text{ V} \\
    2\text{Ag} + \text{H}_2\text{O}_2 & \rightarrow 2\text{Ag}^+ + 2\text{HO}^- \quad E^0 = 0.0680 \text{ V}
\end{align*}
\]
The formation of silver ions as the reaction products from the decomposition of AgNPrs by H$_2$O$_2$ was verified by the addition of a strong reducing agent (NaBH$_4$) into the degraded AgNPr solution. The result in Figure S3 shows that a new plasmon absorption peak at 400 nm emerges in the extinction spectrum, in correspondence with the change of the solution color from colorless to yellow after the addition of sodium borohydride. The plasmon absorption peak at 400 nm is a characteristic plasmon band of silver nanospheres. The silver nanospheres are formed by the following chemical reaction:

\[
\text{Ag}^+ + \text{BH}_4^- \rightarrow \text{Ag}^0 + \frac{1}{2}\text{H}_2 + \frac{1}{2}\text{B}_2\text{H}_6
\]

Therefore, it can be confirmed that the etching reaction of H$_2$O$_2$ on AgNPrs induces the degradation of silver atoms on AgNPrs to silver ions, and leads to the morphological transformation of AgNPrs.

References for Figure S4

Figure S5. Extinction spectra of blue-AgNPrs when exposed to H$_2$O$_2$ at various concentrations ranging from 1 to 1,000 μM, with the corresponding inset photographs showing the color of the colloidal AgNPr solution after incubation with H$_2$O$_2$ for 60 min.
**Figure S6.** Normalized ATR FT-IR spectra of virgin starch, starch on AgNPrs, and starch on AgNPrs after incubation with H$_2$O$_2$ at various concentrations ranging from 1 to 1000 µM for 60 min. The infrared band assignment table is also included.
Figure S7. Red chromaticity level of the AgNPrs with glucose oxidase enzyme (GOx) after incubating with glucose and various potential sugar species. Inset photo shows the corresponding digital images of the AgNPrs solutions.