Electronic Supplementary Information

1. Experimental procedures

Materials: Ultrapure water was used in all of the experiments. Gold(III) acetate (Au(ac)$_3$ 99.9%) was purchased from Alfa Aesar. AgNO$_3$ of analytical grade was purchased from Sinopharm Chemical Reagents. NADPH (reduced β-nicotinamide adenine dinucleotide 2’-phosphate tetrasodium salt) was purchased from Biomol. The Amicon centrifugal filter units were purchased from Millipore.

Synthesis of Au-Ag Alloy Nanoparticles: 0.01 g Au(ac)$_3$ was dissolved in 100 mL ultrapure water to get 0.01% aqueous Au(ac)$_3$ solution. Au(ac)$_3$ and AgNO$_3$ were mixed together in 2 mL ultrapure water. In a total ion concentration of 4×10$^{-4}$ mol/L, the gold mole fractions of added metal ions ($\chi_{Au}$) were 0, 0.25, 0.5, 0.75 and 1 respectively. Then certain amounts of NADPH were added to the solution. The amounts of NADPH were listed as following:

<table>
<thead>
<tr>
<th>$\chi_{Au}$</th>
<th>0</th>
<th>0.25</th>
<th>0.5</th>
<th>0.75</th>
<th>1</th>
</tr>
</thead>
<tbody>
<tr>
<td>NADPH (mg)</td>
<td>0.5</td>
<td>0.75</td>
<td>1</td>
<td>1.25</td>
<td>1.5</td>
</tr>
</tbody>
</table>

The mixture was gently stirred for 24 h at room temperature. The products were purified using an Amicon centrifugal filter unit (molecular-weight cut-off (MWCO) =10 kDa) and then dispersed in water. The alloy nanoparticles were freeze-dried to obtain the powder for further characterization.

Characterization Methods: The transmission-electron-microscopy (TEM) images were obtained using a JEOL JEM-1230 transmission electron microscope at 100 kV. Samples for TEM were prepared by dropping 5 μL of a solution of the Au clusters onto a Formvar coated copper grid and allowing it to dry. High resolution Transmission electron microscopy (HRTEM) images were taken on JEOL JEM-2010FEF transmission microscopy at 200 kV. Samples for HRTEM were prepared on ultrathin-carbon-coated grids in the same way mentioned above. X-ray diffraction (XRD) data were recorded on Bruker AXS D8 advance X-ray diffractometer. Samples of AuNPs solution were dropped on the substrate and allowed to dry as a uniform thin film. The XPS data were recorded using a Kratos XSAM 800 X-ray photoelectron spectrometer. The binding energy of the XPS data was referenced to the C 1s of aliphatic carbon at 284.8 eV. The FTIR spectra were recorded using a Nicolet Nexus 670 infrared spectrometer.

2. Supporting Figures
**Fig. S1** UV-vis spectrum of mixture solution of AuNPs and AgNPs in equimolar amounts.

**Fig. S2** Infrared spectra of pure NADPH and Au-Ag alloy nanoparticles ($\chi_{\text{Au}}=0.5$).
**Fig. S3.** XRD patterns of Au-Ag alloy nanoparticles on glass substrates.

**Fig. S4.** High resolution TEM image of Au-Ag alloy nanoparticles. (a) $\chi_{\text{Au}} = 0.25$, (b) $\chi_{\text{Au}} = 0.5$, (c) $\chi_{\text{Au}} = 0.75$. 