

Supplementary information

By using volume integral equation method, we simulated the absorption spectra which occur due to the change in the shape of the gold nanorods on addition of sodium hydroxide. Figure 1 are the models of nanorods, dumbbell-1, dumbbell-2 and dumbbell-3 with the corresponding simulation grids numbers being 22036, 24220, 23150 and 25396, respectively. The dimensions of models a and d are taken from experimental observations, whereas b and c are generated theoretically. Table 1 lists the specific parameters used in the simulations and their results of the band positions.

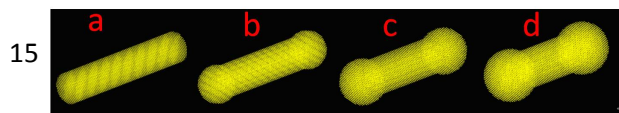
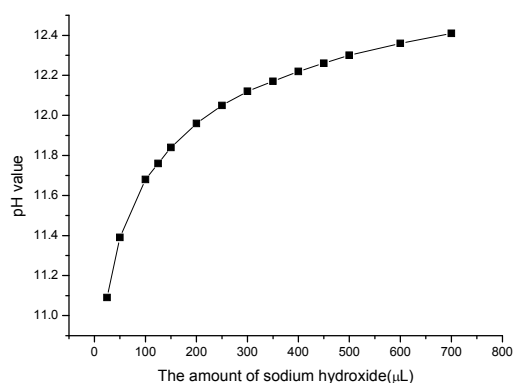
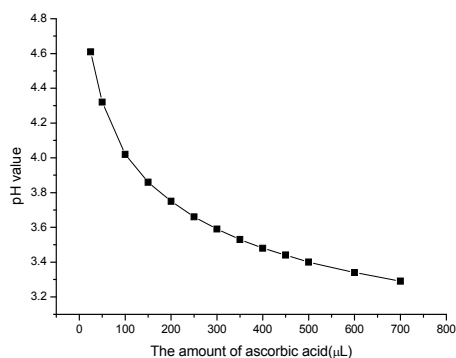


Figure 1. Simulation grid of NPs, a,b,c,d is the models of nanorods, dumbbell-1, dumbbell-2 and 3. The corresponding simulation grids numbers are 22036, 24220, 23150 and 25,396, respectively.

On addition of different quantities of sodium hydroxide (NaOH) solution to goldnanorods for growing the nanodumbbells with spherical ends, the amount of sodium hydroxide are changed from 25, 50, 100, 125, 150, 200, 250, 300, 350, 400, 450, 500, 600, to 700 (μL). By the concentration of the sodium hydroxide, the corresponding pH values of the solutions are estimated as 11.09, 11.39, 11.68, 11.76, 11.84,



11.96, 12.05, 12.12, 12.17, 12.22, 12.26, 12.3, to 12.36, 12.41 respectively (a)



(b)

Figure 2. The plot of pH values of the solutions of nanorods as a function of the amounts of sodium hydroxide (a) and ascorbic acid shown in (b).

shown in Figure 2 (a). As shown in the following Figure 2 (b) When the Au nano-dumbbell with arrow ends prepared by adding various amount of ascorbic acid solvent to Au nanorods seeds, the amount of ascorbic acid are changed from 25, 50, 100, 150, 200, 250, 300, 350, 400, 450, 500, 600, 700 (μL), and the corresponding PH values of the solutions are estimated as 4.61, 4.32, 4.02, 3.86, 3.75, 3.66, 3.59, 3.53, 3.48, 3.44, 3.4, 3.34, 3.29, respectively.

We synthesized the spherical ended and arrow ended gold nanodumbbells by introducing gold nanorods to a solution of sodium hydroxide and ascorbic acid, respectively. Here, as example, we gave the TEM images in the middle of the growth stages of case of the spherical ended nanodumbbells. As shown in Figure 3, it is clearly shown that the product in the middle of the growth stages is unique, only the spherical ended gold nanodumbbells were synthesized, no other intermediate like dogbone and peanut so on appeared in the reaction process. Figure 3 (A) shows the TEM images of two arbitrary single gold nanorode in initial stage when no sodium hydroxide is added in the solution. Figure 3 (B) shows the TEM images of two arbitrary single gold nanorode in middle stage when an amount of sodium hydroxide is added in the reaction solution. Here, the gold nanorode becomes more fatter than that of gold nanorode in (A). Moreover, the shape of the rod ends is extended a little bit in the transverse direction (as shown by the white profile along the rod fringe), which corresponds to the middle situation in Fig. 5 in the main text. And with the more amount of sodium hydroxide is added in the reaction solution, the ends of the gold nanorode are becoming more fatter as shown in figure 3 (C), which forms the gold nanodumbbells with obviously spherical ended at the final stage. This TEM observation are consistent with our plasmonic spectra proof. Detailed TEM investigation will be carried in future works.

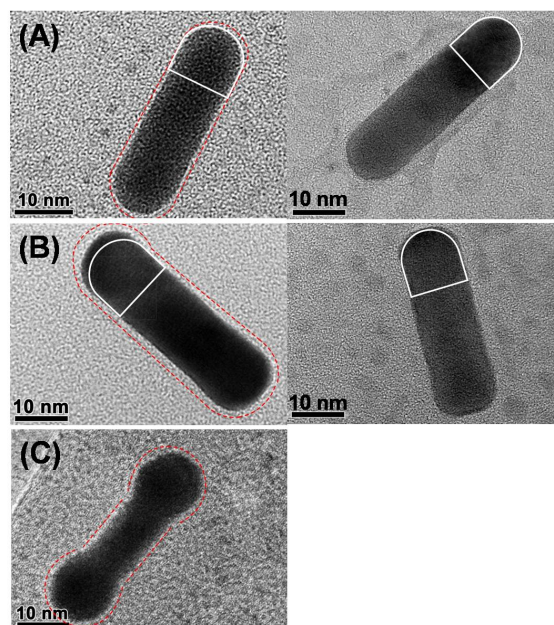


Figure 3. The TEM image of gold nanorode. (A) Two arbitrary single gold nanorode of initial stage when no sodium hydroxide is added in the reaction solution. (B) Two arbitrary single gold nanorode when an amount of sodium hydroxide is added in the reaction solution of middle growing process. (C), The gold nanodumbbells with obviously spherical ended at the final stage.

Table 1: Parameters used in the simulations.

* The italic number in the last two columns are experimental values

models	length	diameter	End -diameter	error	L_peak nm	T_peak nm
Naorods	47.95	9.16	9.16	0.01	924/932*	509/516*
Dumbell-1	50.81	11.37	13.15	0.01	897	515
Dumbell-2	53.67	13.59	17.14	0.01	853	521
Dumbell-3	56.53	15.81	21.13	0.01	810/802*	522/506*