Electronic Supplementary Material (ESI) for Journal of Materials Chemistry A

Supporting Information

A new strategy for the surface-free-energy-distribution induced selective growth and controlled formation of Cu_2O-Au hierarchical heterostructures with a series of mophological evolutions.

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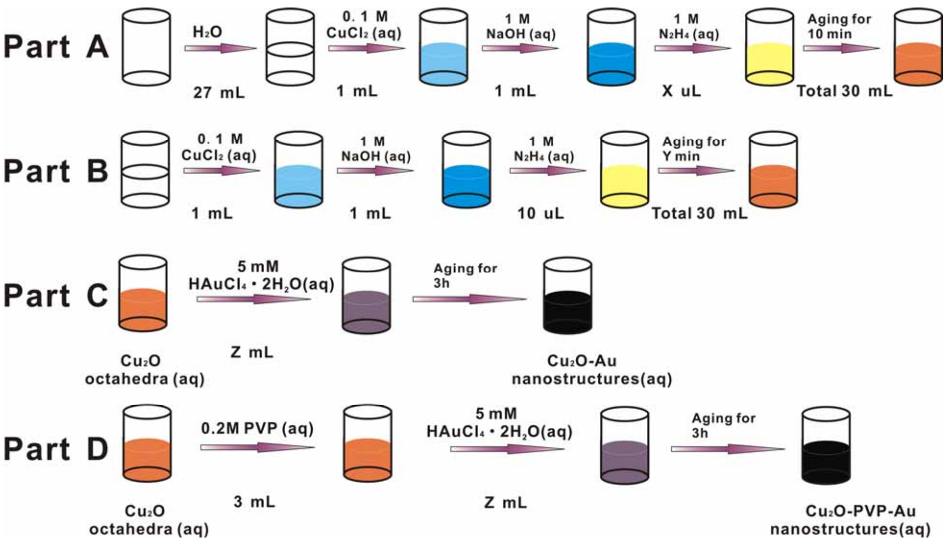

Scheme S1 Schematic illustration of the procedure used to synthesize (part A and B) Cu_2O crystals, (part C) Cu_2O-Au hierarchical heterostructures and (part D) Cu_2O-PVP-Au heterostructures.

Products	*0.1 M $CuCl_2$ (mL)*	*1.0 M NaOH (mL)*	*1 M N_2H_4 (μL)*	*0.2 M PVP*	*H_2O (m L)*	*5 mM $HAuCl_4$ (aq)*	*Aging time (min)*
a. cubic octahedral			10				
ctahedron			40				
b. octahedron			80				
d. octahedron			120				10
e. corrosive-octahedron			200				
f. face-holed octahedron			300				
g. cubic octahedral							10
h. octahedron			10		27		30
i. octahedron	1	1					60
j. Au nanoclusters growth along the crystal edges of octahedron			120			0.25	
k. Au nanoclusters growth on the crystal faces of octahedron			120			0.5	
l. Cu_2O-Au nanostructures			120			0.75	180
m. Au nanowhiskers						1	
n. Cu_2O-Au heterostructures			120			0.25	
o. Cu_2O-Au heterostructures			120	3		0.5	
p. Cu_2O-Au heterostructures			120			0.75	
q. Cu_2O-Au heterostructures			120			1	

Table S1 Different products and their amount of all chemicals.

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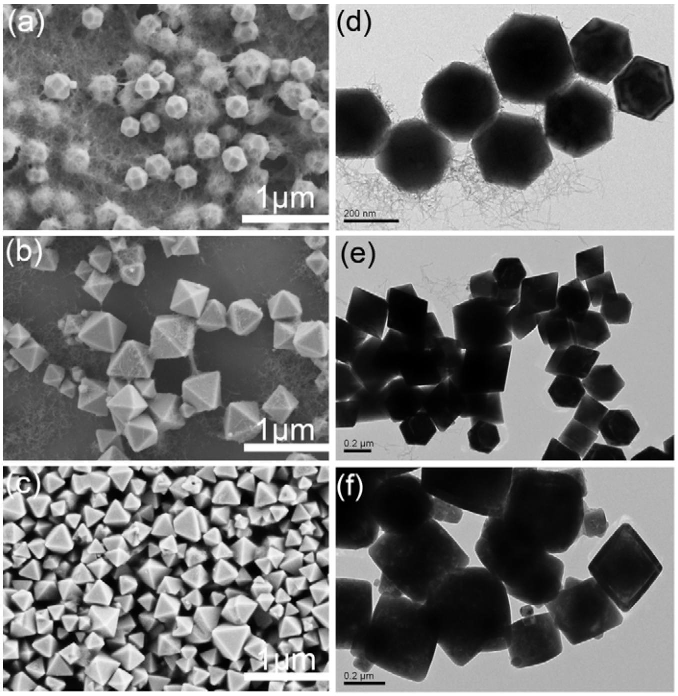

Fig. S1 FE-SEM and TEM images of Cu_2O nanocrystal evolution from cubic octahedral to octahedron with 10 µL of hydrazine hydrate. The reaction times of each sample are 5 min (a), 20 min (b) and 60 min (c), respectively.

Three main reasons can accounts for these phenomena. 1. The cuboctahedral and octahedral Cu_2O bound by {111} and {100} facets were formed owing to the different growth rates along <100> versus <111> directions. A strong reductant such as $N_2H_4{\cdot}2H_2O$ is helpful to the growth of Cu_2O {111} planes, while the weaker reductant such as sodium ascorbate is adopted, the Cu_2O become cubes with six {100} facets. 2. At the same reaction time, the more $N_2H_4{\cdot}2H_2O$ adopted, the more growth rates of {111} facet acquired, resulting the evolution from cuboctahedron to octahedron. 3 As the reaction progress, the N_2H_4 can absorb on {100} planes of cuboctahedrons and suppress the growth of {100} planes, resulting the formation of octahedrons.

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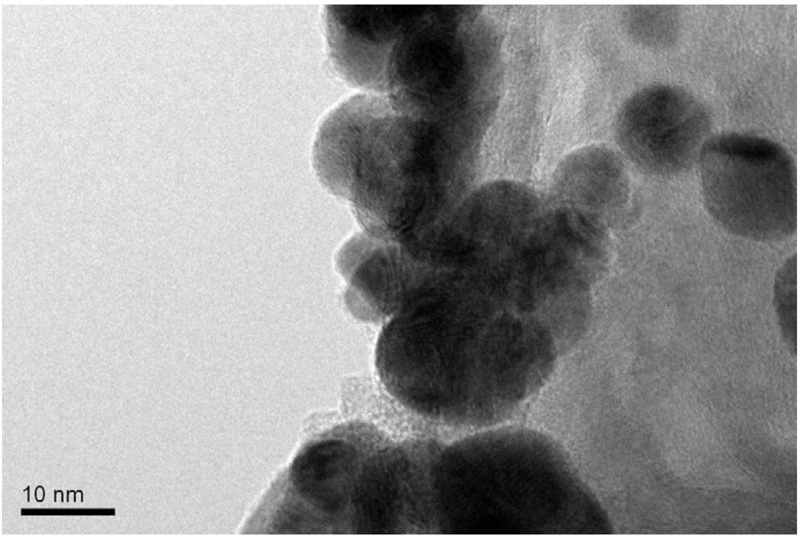


Fig. S2 TEM image of the AuNGs comprised by several small Au nanoparticles.

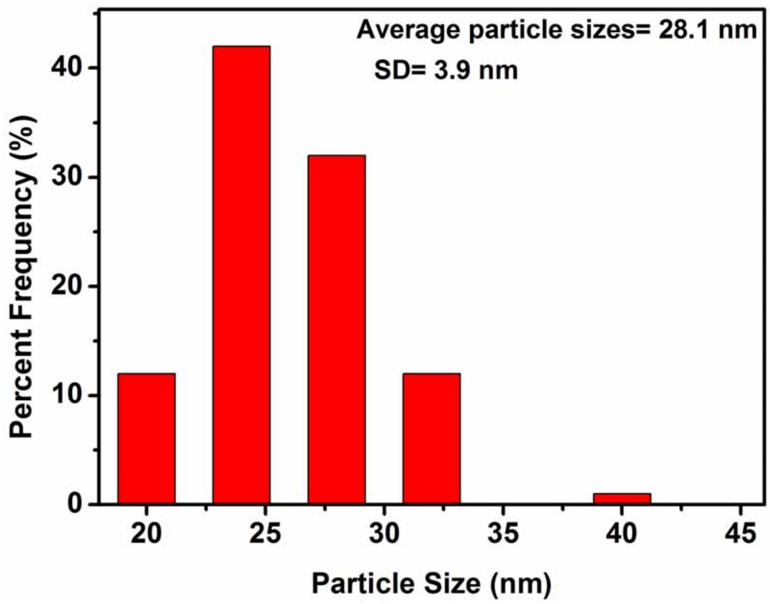


Figure S3. The average particle size of the AuNGs.

Image-Pro Plus 6.2 software was used to obtain the size distributions diagrams of AuNGs and the number of AuNGs is 400.

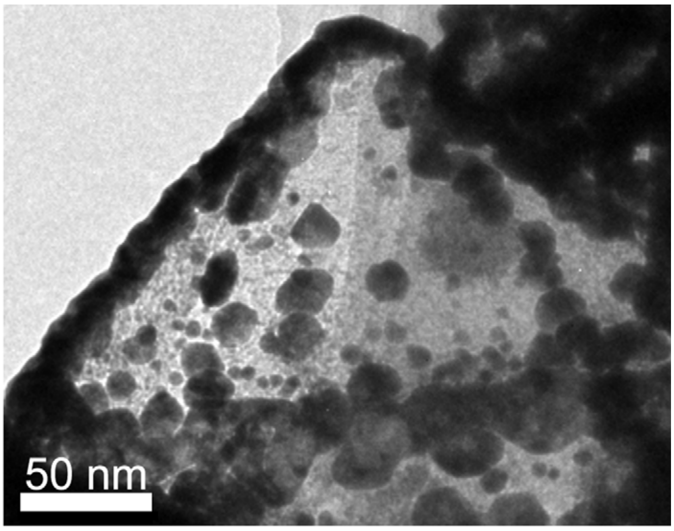


Fig. S4 TEM image of the Cu_2O-Au heterostructures with pores and splits.

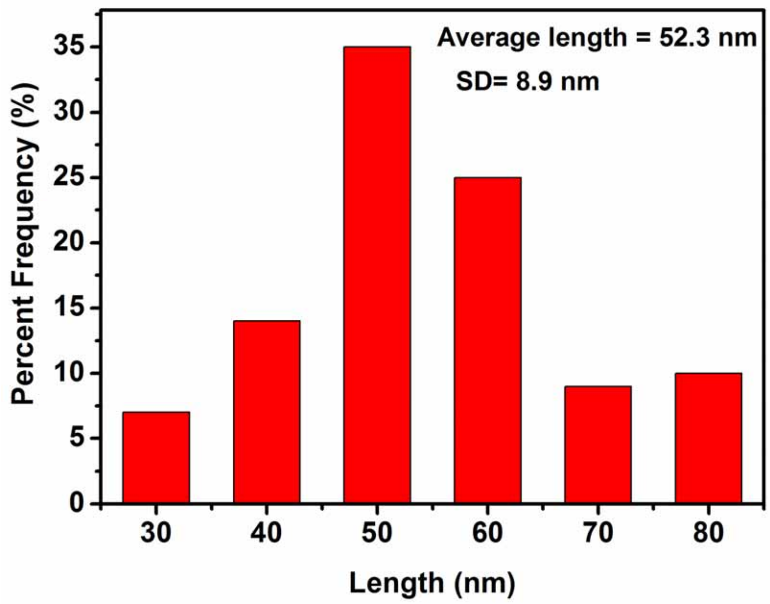


Fig. S5 The average length of the AuNWs.

Image-Pro Plus 6.2 software was used to obtain the size distributions diagrams of AuNWs and the number of AuNWs is 400.

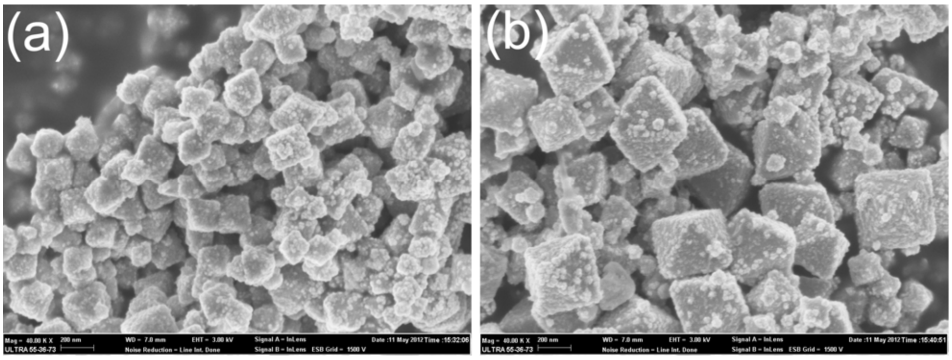
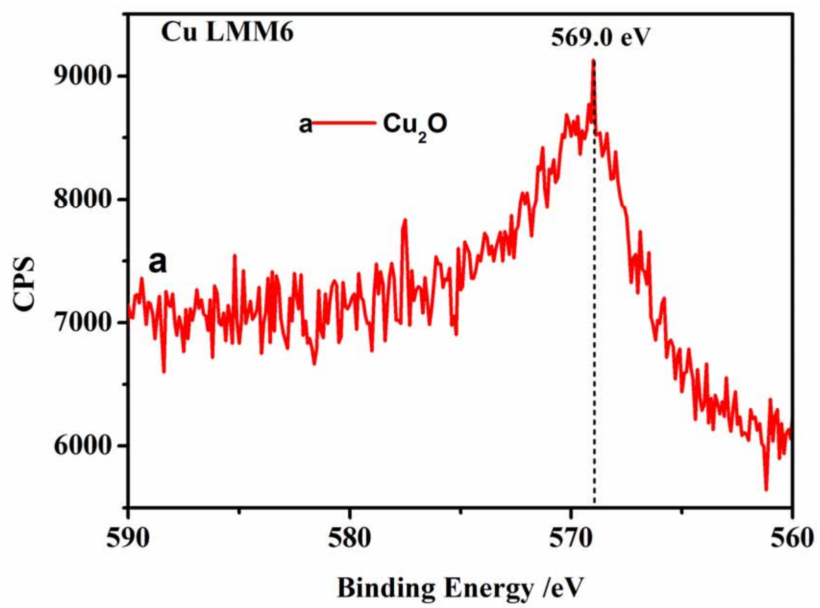


Fig. S6 FE-SEM images Cu_2O-PVP-Au heterostructures. (0.5 mL $HAuCl_4$)

Due to the decreasing of diversity of the surface energy distribution between {111} facets and crystal edges with the introduction of PVP, the trend of the selective growth on the crystal edges is significantly drop down.



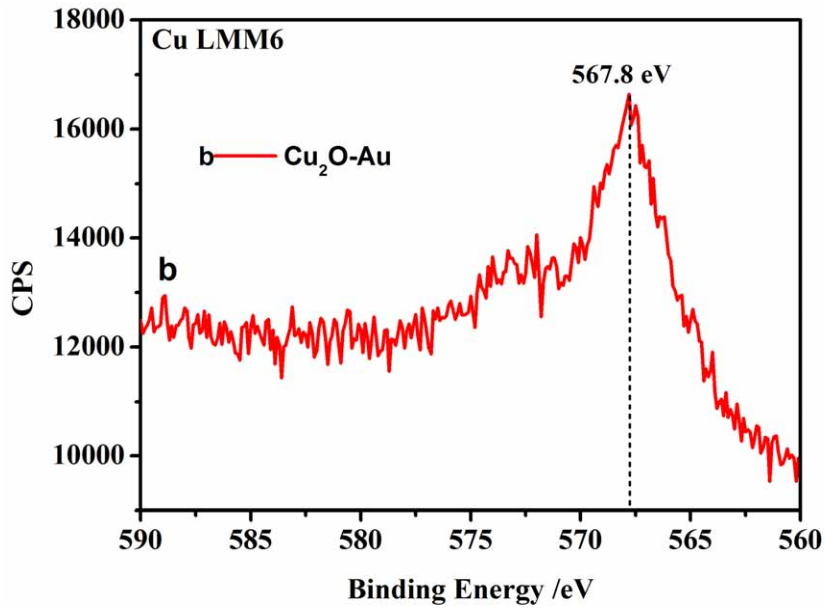
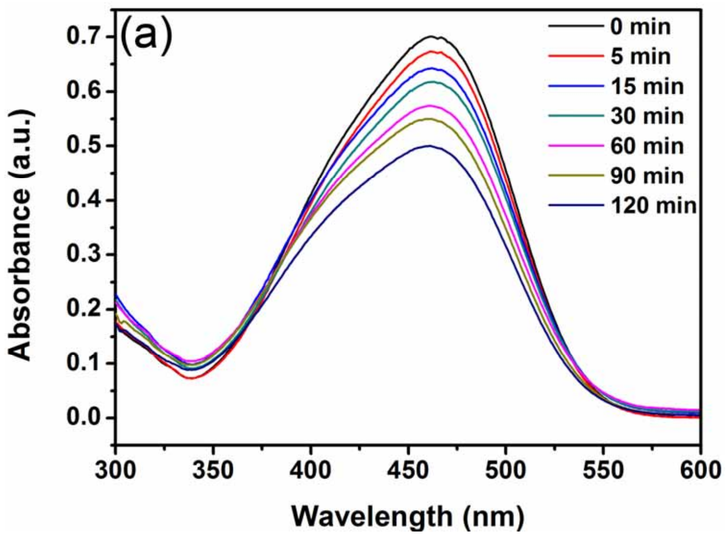
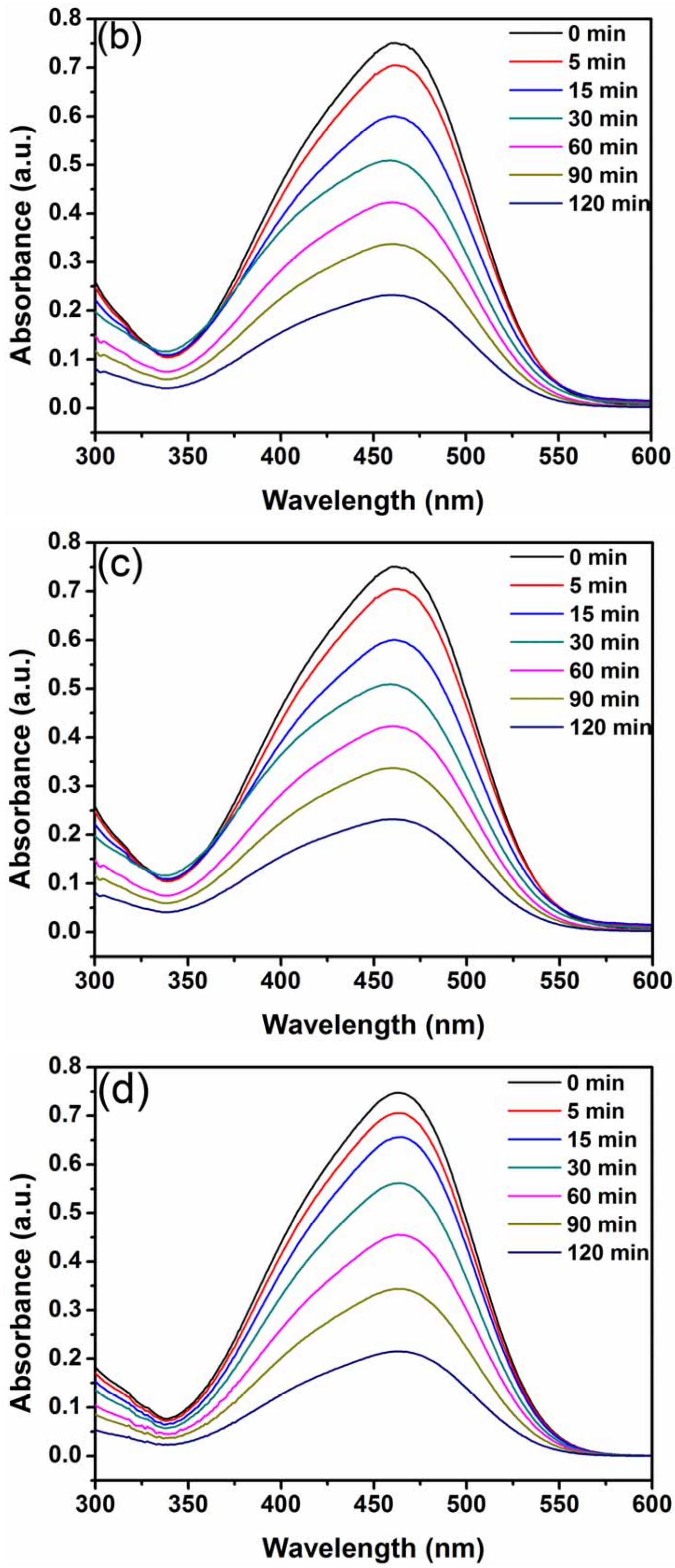


Fig. S7 The Cu LMM Auger peaks of (a) Cu_2O octahedrons and (b) Cu_2O-Au heterostructures.




(b)
(c)
(d)
Absorbance (a.u.)
Wavelength (nm)
0 min
5 min
15 min
30 min
60 min
90 min
120 min
0.0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
300
350
400
450
500
550
600

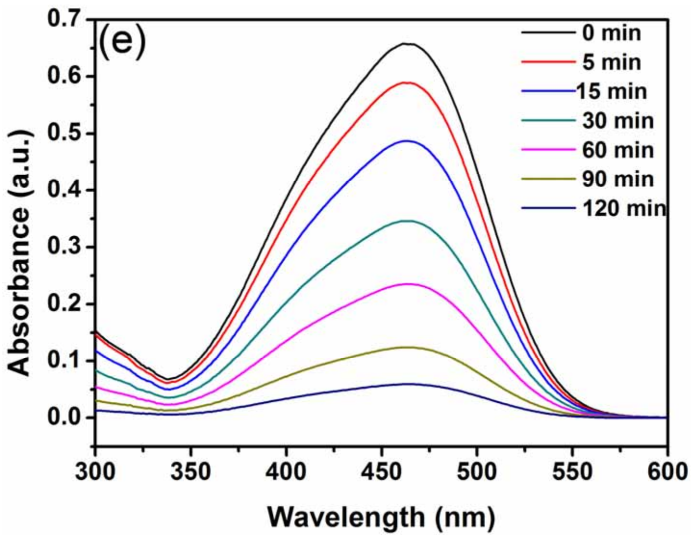


Fig. S8 UV-Vis absorption spectra of methyl orange as a function of irradiation time using (a) Cu_2O octahedrons, (b) Cu_2O decorated by 0.25 mL $HAuCl_4$, (c) Cu_2O decorated by 0.5 mL $HAuCl_4$, (d) Cu_2O decorated by 0.75 mL $HAuCl_4$, (e) Cu_2O decorated by 1 mL $HAuCl_4$.