Electronic Supplementary Material (ESI) for Nanoscale

Supporting Information

In Situ TEM Observation of Au-Cu_2O Core-Shell Growth in Liquid

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Supplementary Figures

Figure S1– Schematic diagram of the specific E-chips in Protochips Poseidon 200.
Figure S2 – A series of images illustrating the assembly process of the E-chips and O-rings.
Figure S3 – Schematic illustration of the liquid cell construction.
Figure S4 – TEM images of different focal planes.
Figure S5 – A series of in situ TEM images showing the synthesis of multifaceted core-shell nanoparticles.
Figure S6 – The multifaceted structure and cubic structure in different concentration of sodium citrate.
Figure S7 – The HRTEM of multifaceted structure and cubic structure.
Figure S8 – The EDS spectra of two types of core-shell structures.
Figure S9 – A series of TEM images showing the dissolution of cuprous oxide due to the effects of the electron beam.

Supplementary Movies

Movie S1 – assembly in the Protochips Poseidon 200.
Movie S2 – in situ TEM video: different focal planes of the gold nanoparticles.
Movie S3 – in situ TEM video: synthetic process for multifaceted core-shell nanoparticles.
Movie S4 – in situ TEM video: particle motion.
Movie S5 – in situ TEM video: synthetic process for cubic core-shell nanoparticles.
Movie S6 – in situ TEM video: dissolution of the Cu2O shell.

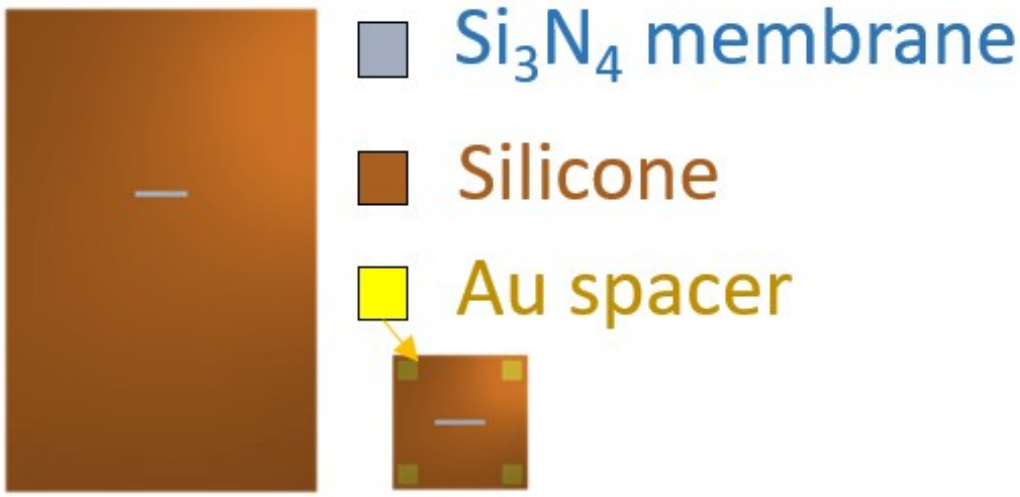

Figure S1. Schematic diagram of the specific E-chips used in the Protochips Poseidon 200. The left image is the top chip, and the right image is the bottom chip. The size of the bottom chip is 2.3 mm x 2.3 mm, and the thickness of the Au spacer is 150 nm for sealing the precursor solution. The size of the top chip is 4 mm x 5.8 mm. The center of each chip is the 60 nm thick Si_3N_4 membrane used as an observation area.

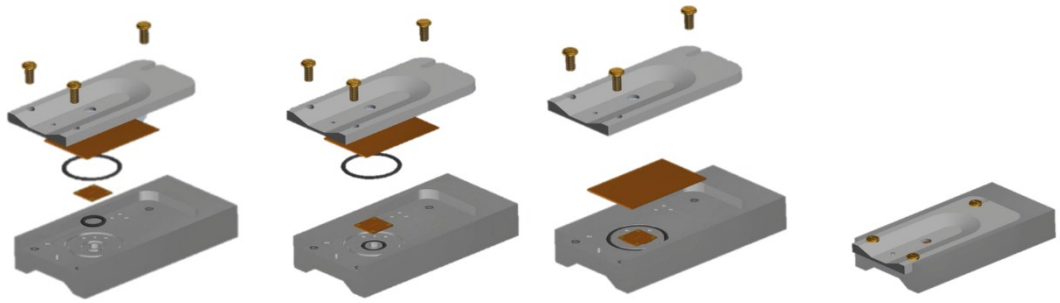

Figure S2. A series of images illustrating the assembly process of the E-chips and O-rings.

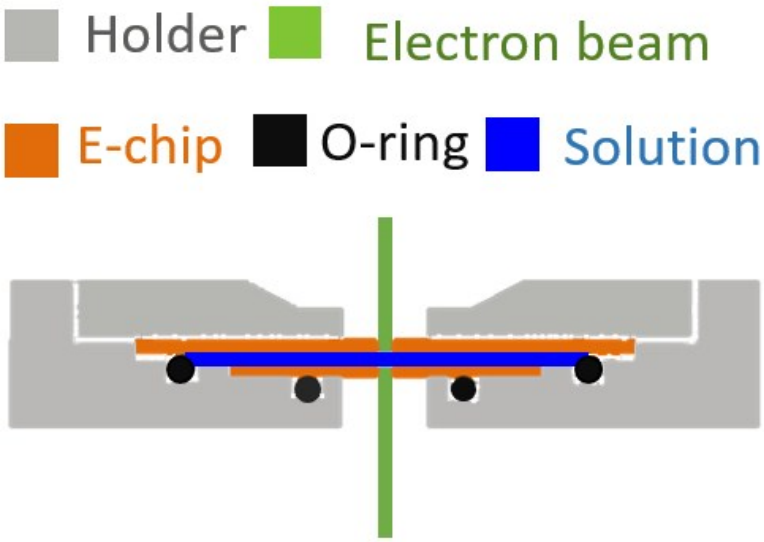

Figure S3. Schematic illustration of the liquid cell construction. Solutions flowed between the E-chips and O-rings and the electron beam penetrate through the middle of the sample. The electron beam was only transmitted through the Si_3N_4 membrane and solution. The total thickness is approximately 200 nm. This thickness is the most suitable for observing the chemical reactions in our experiment.

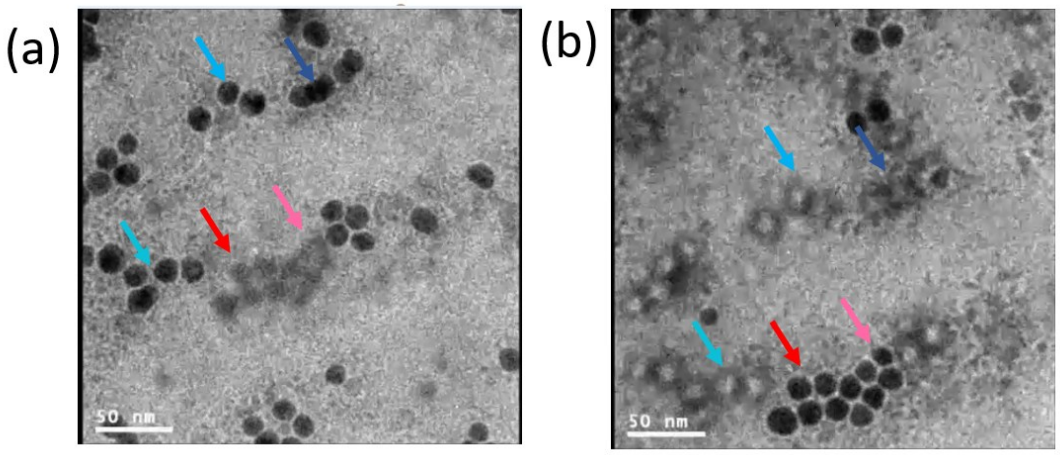

Figure S4. TEM images of different focal planes, which indicate that gold nanoparticles stick to the upper and bottom silicon nitride membranes. (a) image focused on the gold nanoparticles indicated by the blue arrows and (b) image focused on the gold nanoparticles indicated by the red arrows. The focal distance is approximately 200 nm.

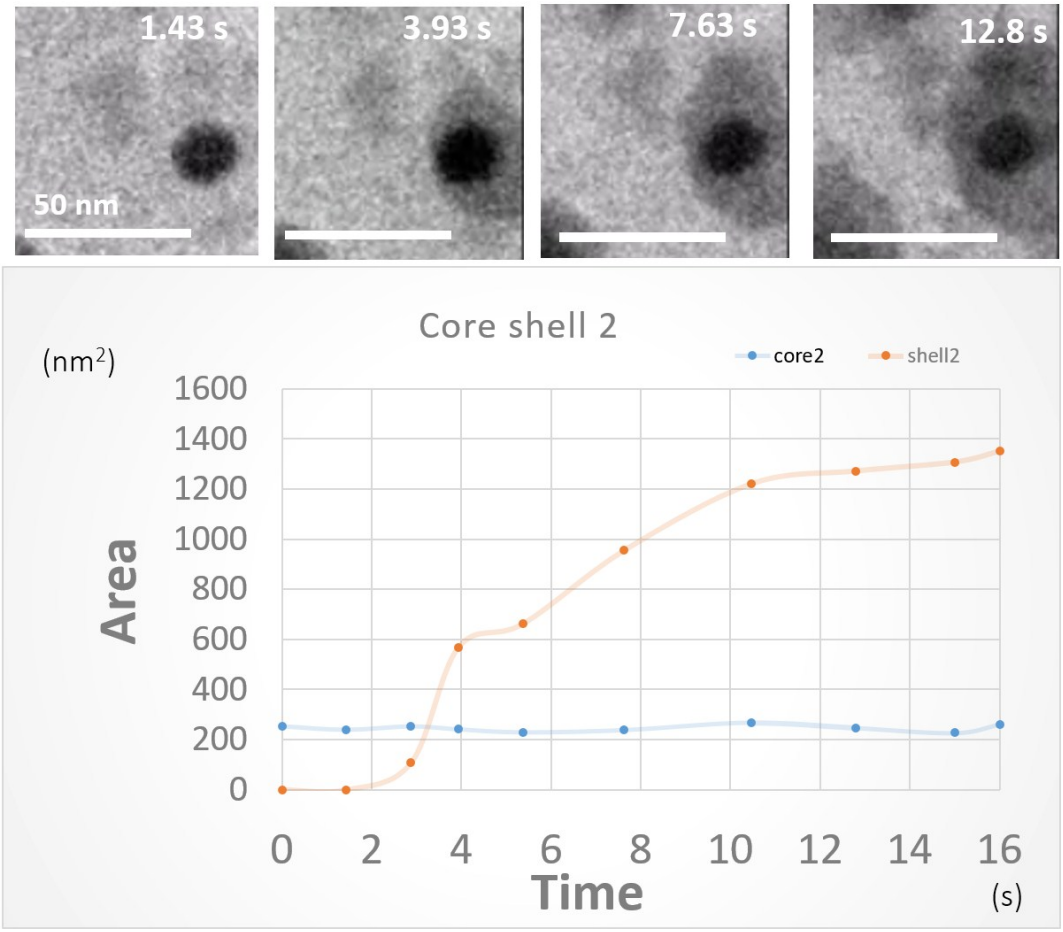

Figure S5. A series of in situ TEM images from Movie S3 showing the synthesis of multifaceted core-shell nanoparticles. The curves are the area as a function of time for the core and shell. The growth rate is 150 nm^2/s.

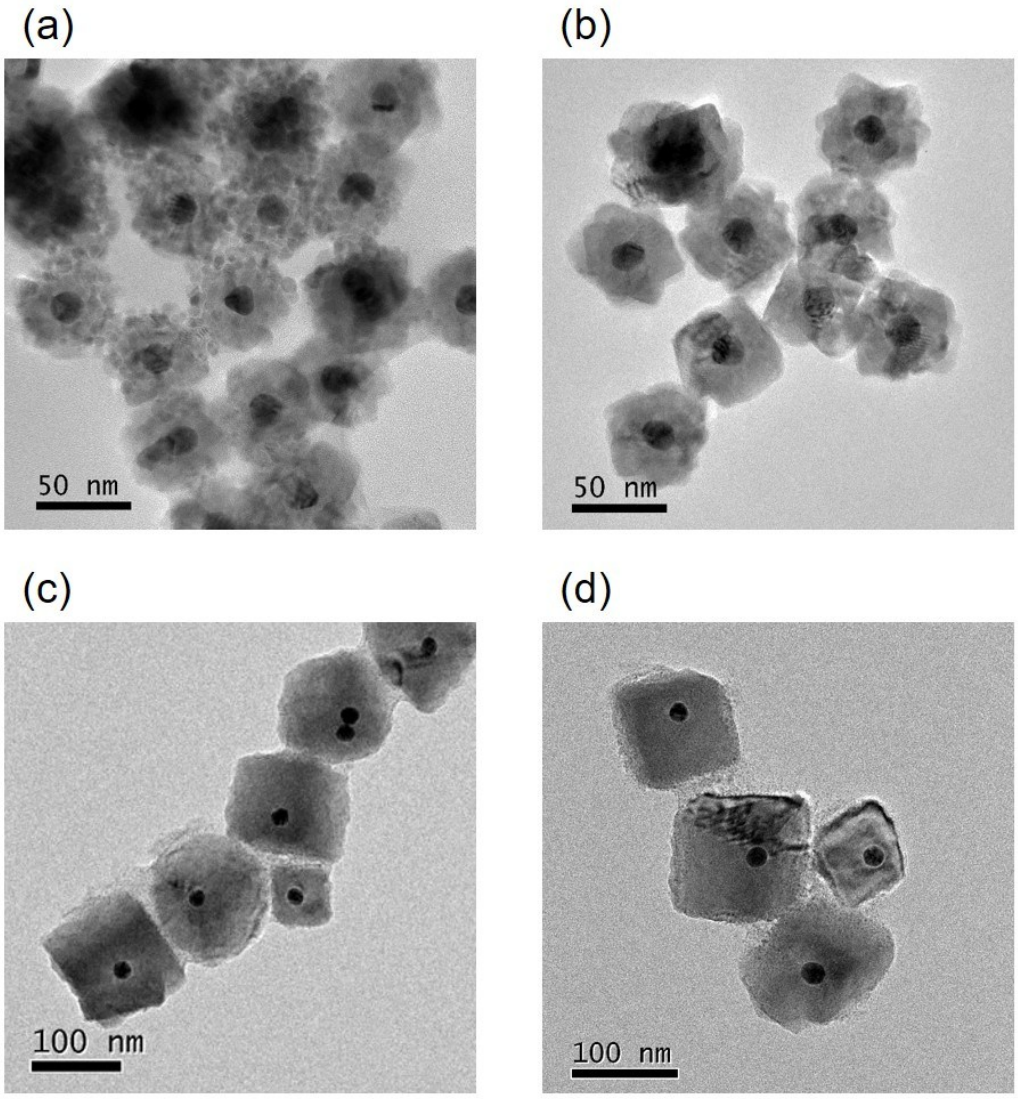

Figure S6 – The multifaceted structure and cubic structure in different concentration of sodium citrate. (a, b) The higher concentration of sodium citrate would lead to multifaceted NP grow easier. (c, d) The lower concentration of sodium citrate would lead to cubic NP grow easier.

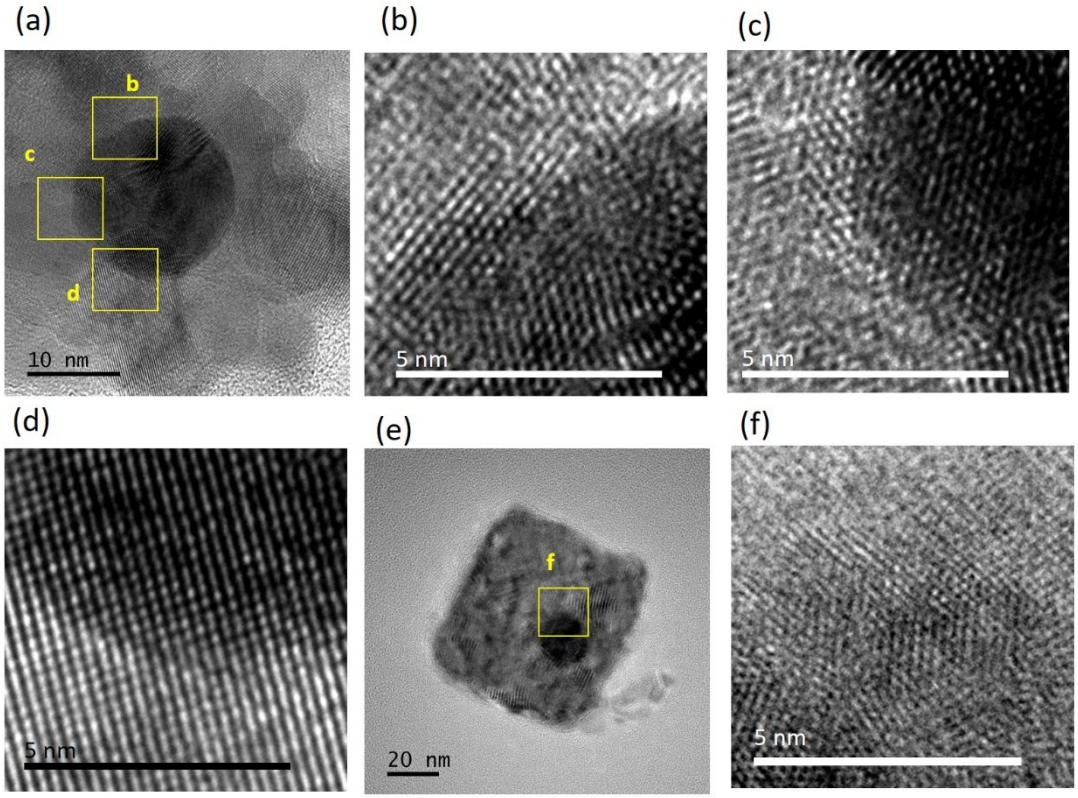

Figure S7 – The HRTEM of multifaceted structure and cubic structure. (a-d) The multifaceted nanoparticle shows well epitaxial relation in each facets. (e-f) The cubic nanoparticle shows Cu_2O epitaxially grew at the limiting place.

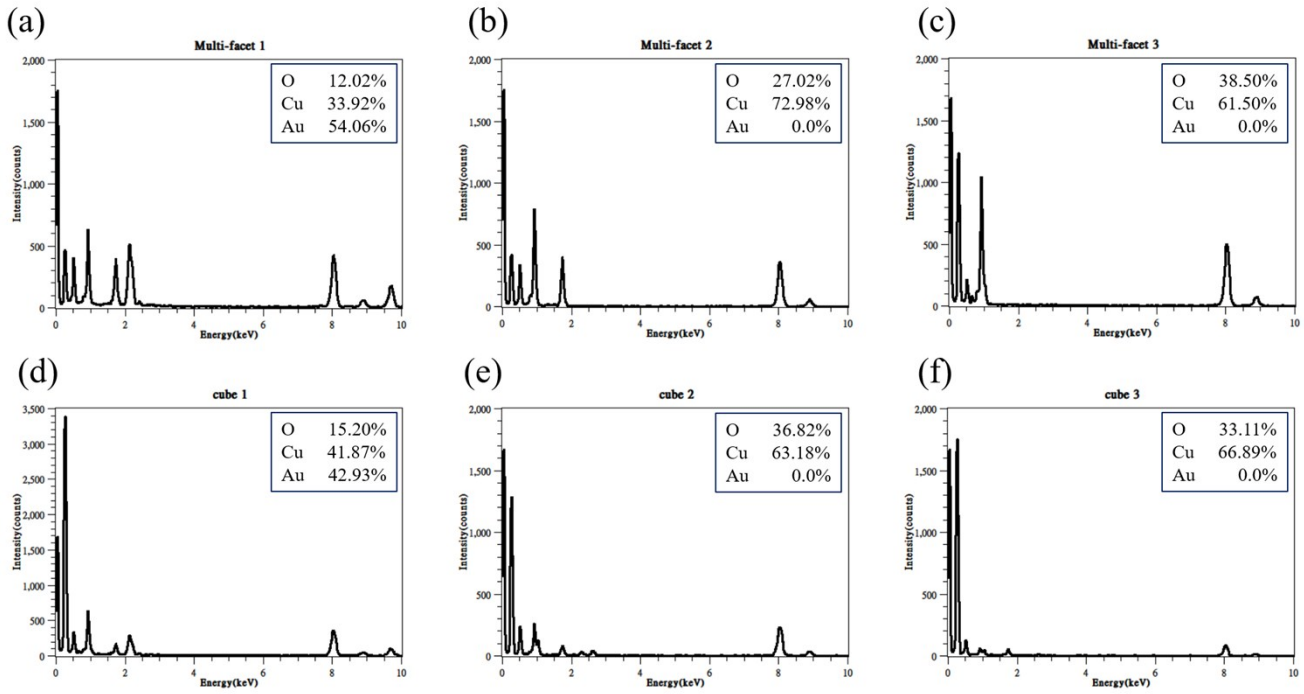

Figure S8. The EDS spectra of two types of core-shell structures. (a-c) Point analysis of the multifaceted core-shell nanoparticles and (d-f) point analysis of the cubic core-shell nanoparticles.

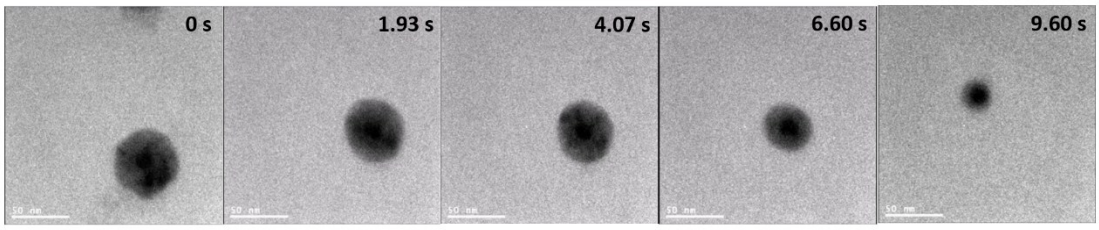

Figure S9. A series of TEM images showing the dissolution of cuprous oxide due to the effects of the electron beam. The diameter is 50 nm at 0 s and 20 nm at 9.6 s.