Supplementary Material (ESI) for Chemical Communications

Supporting Information

Synthesis and Characterization of Indium Oxide Nanobubbles with Ultrathin Single Crystal Shells

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Experimental Section

The single crystal In_2O_3 nanobubbles were synthesized by a two-step method. First step, well mixed Ga_2O_3 and In_2O_3 powder (weight ratio 10:1) served as the source was put into an alumina boat, which was positioned in the middle of a horizontal quartz tube held in an electric furnace. After quartz tube was pumped to about 10^{-2} Torr, it was heated up to 900 ^{0}C. Then 50 standard cubic centimeters per minute (sccm) NH_3 and 50 sccm Ar was introduced into the quartz tube. The pressure of the whole system was kept at 23 Torr by the gas source for 30 minutes with continuous pumping. Then the whole system was naturally cooled down to room temperature. The grey-yellow powder product, mixture of GaN and indium particles, was collected in the boat where the source material was positioned.

Second step, the product from the first step was put into another alumina boat as precursor. 2 nm Au coated single crystal Si (100) wafer was put on the alumina boat over the source with Au side down. The Si wafer is used as the substrate and the Au will act as catalyst. The quartz tube was pumped to 10^{-2} Torr and heated to 900 °C. Then pumping was stopped and whole system was maintained at 900 °C for 30 min. However, no any carrier gas was introduced. After the whole system was naturally cooled down to room temperature, the grey-white products on underside surface of the Si wafer were characterized by field emission scanning electron microscope (FE-SEM JEOL JSM-6700F), X-ray diffraction (XRD), and high resolution transmission electron microscopy (HRTEM JEOL 2010).

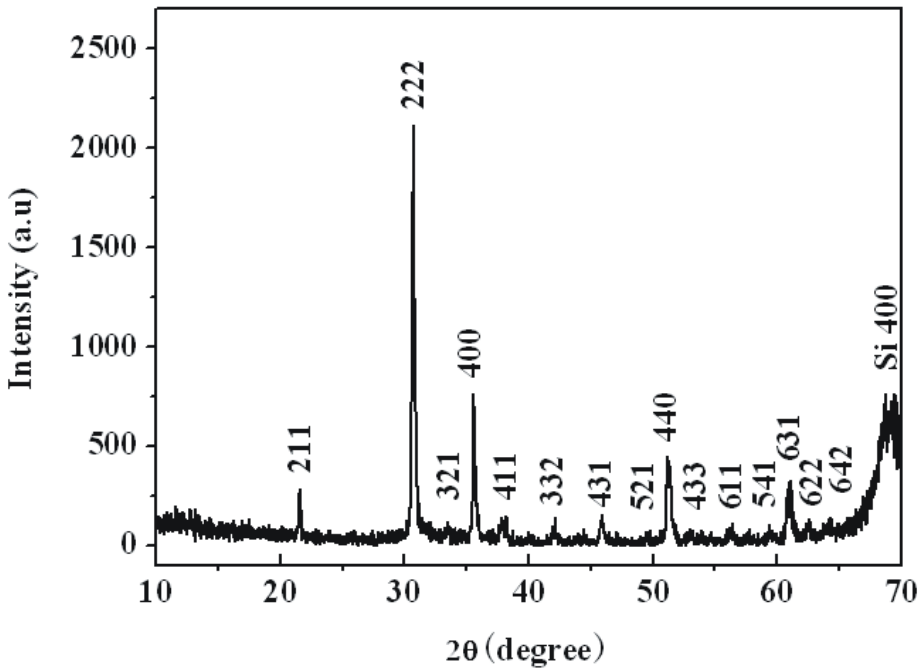

Figure S1. XRD pattern of as-prepared products. All peaks can be indexed to cubic In_2O_3 (JCPDS NO. 76-0152).

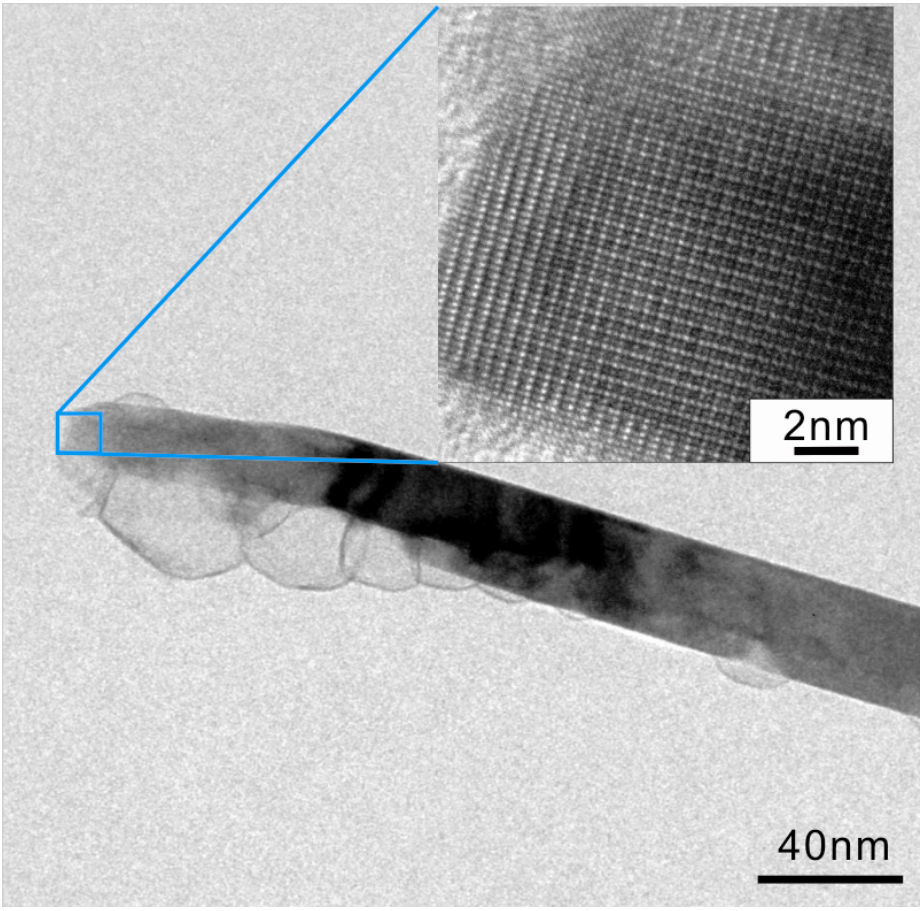

Figure S2. TEM image of a nanorod with nanobubbles on its surface. Inset shows the high-resolution TEM of the nanorod, indicating In_2O_3 single crystal structure.

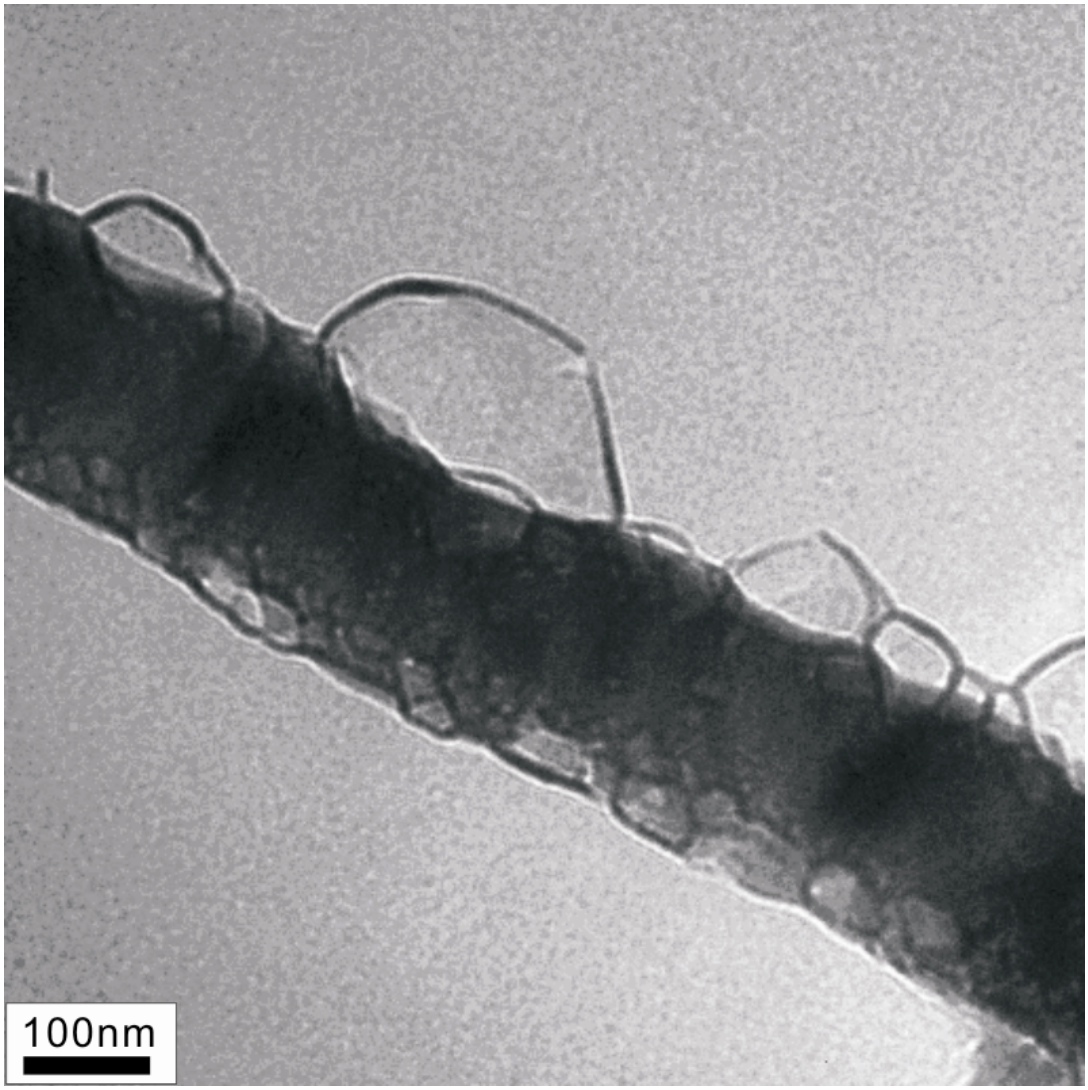

Figure S3. Nanobubbles with different sizes on the surface of an In_2O_3 nanorod. Small nanobubbles look like foaming from the nanorod.

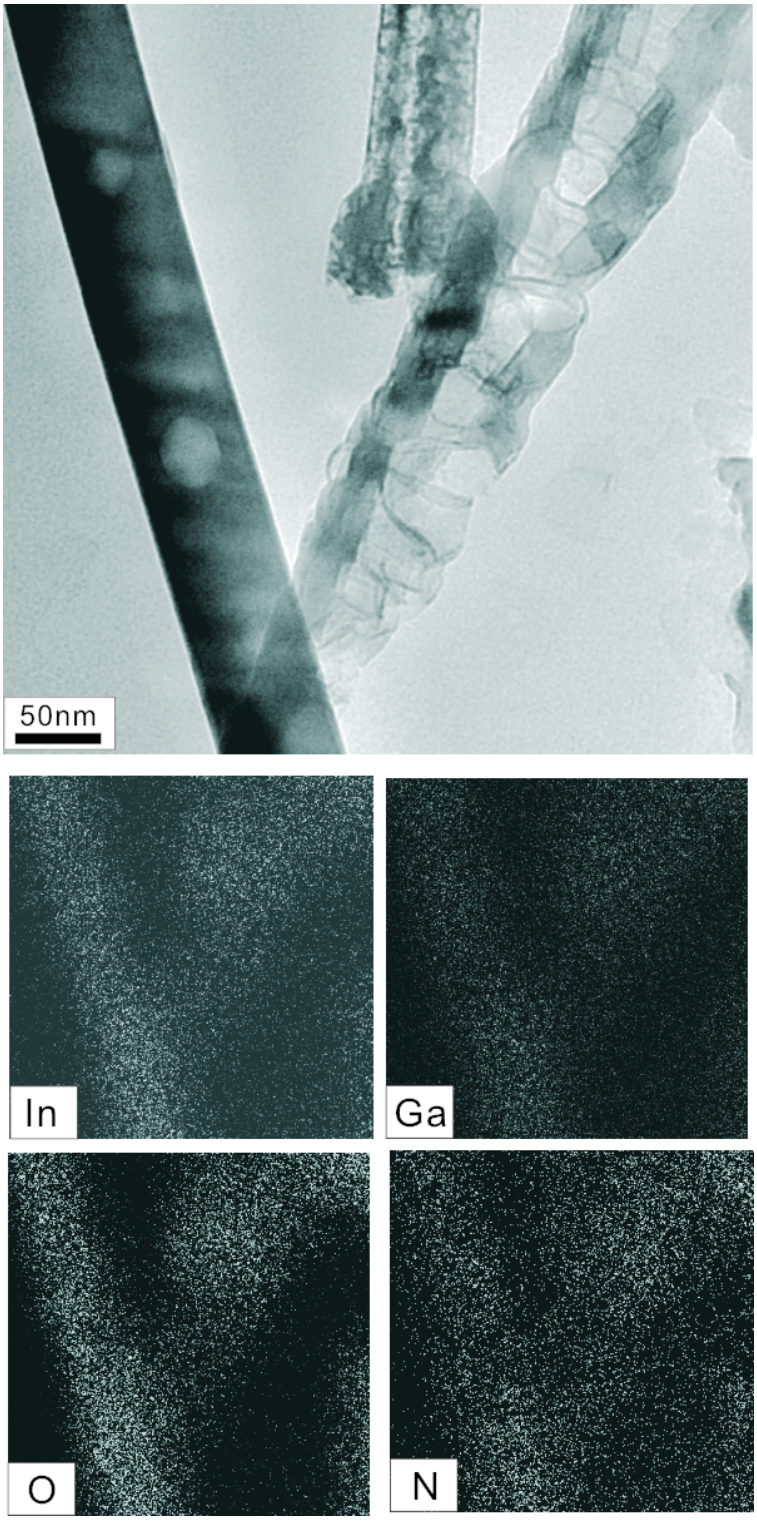

Figure S4. (Above) TEM image of an In_2O_3 nanorod (left) and aggregated nanobubbles (right). (Below) In, Ga, O and N elemental mapping of the nanorod and the nanobubbles, which reveals that the nanorod contains Ga and N elements.

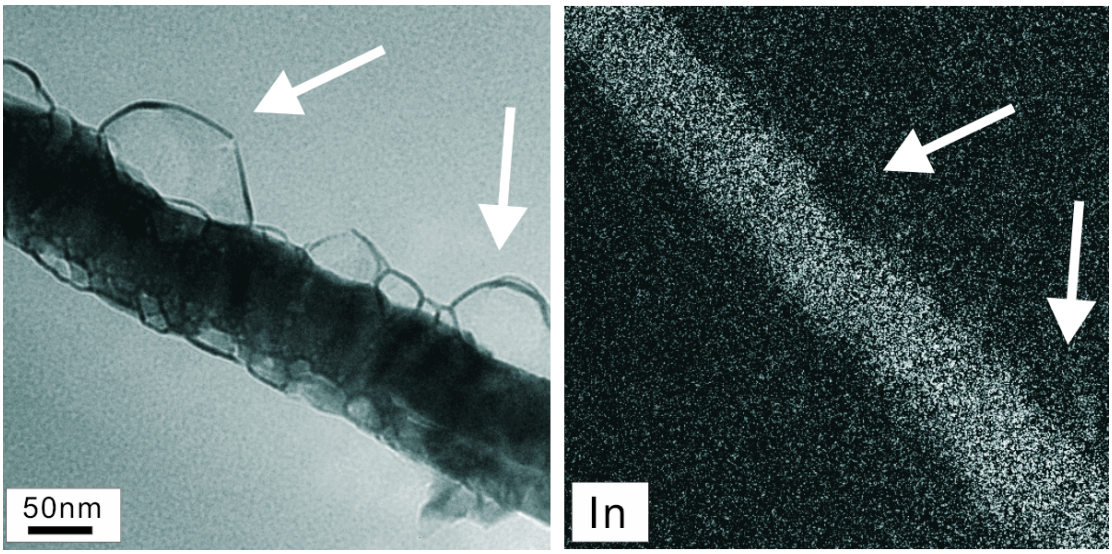

Figure S5. (Left) TEM image of an In_2O_3 nanorod with many nanobubbles on its surface. (Right) Elemental mapping of In along the nanorod and on the shells of nanobubbles (arrows). This is an evidence to show In element on the shells of nanobubbles.

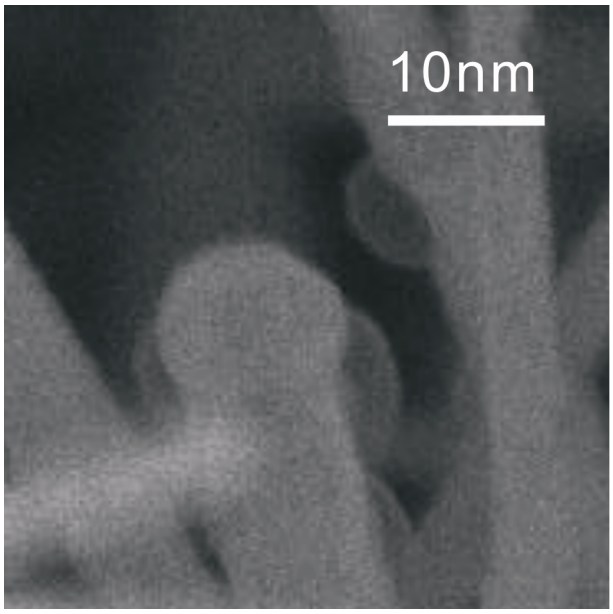

Figure S6. A bubble locates at the joint of a catalyst alloy and a nanorod.

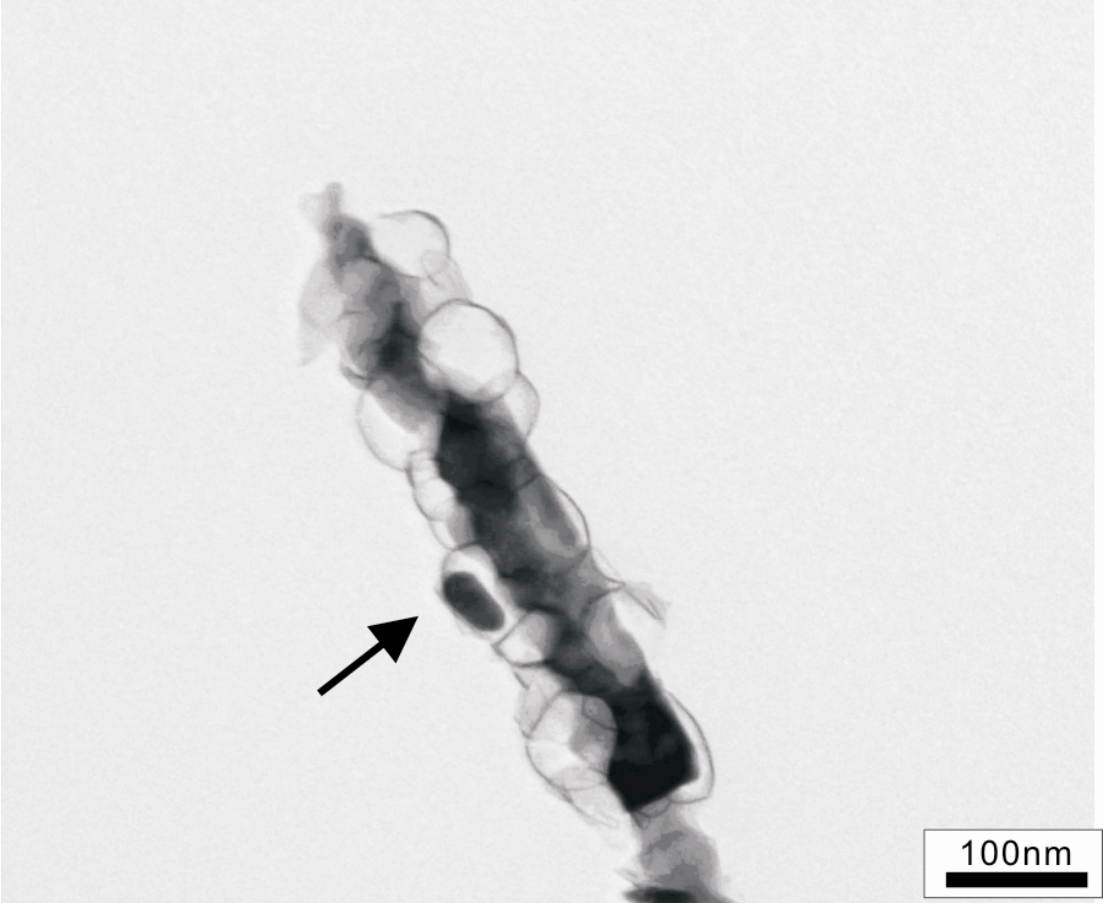

Figure S7. Au nanoparticle (arrow) left inside a nanobubble.

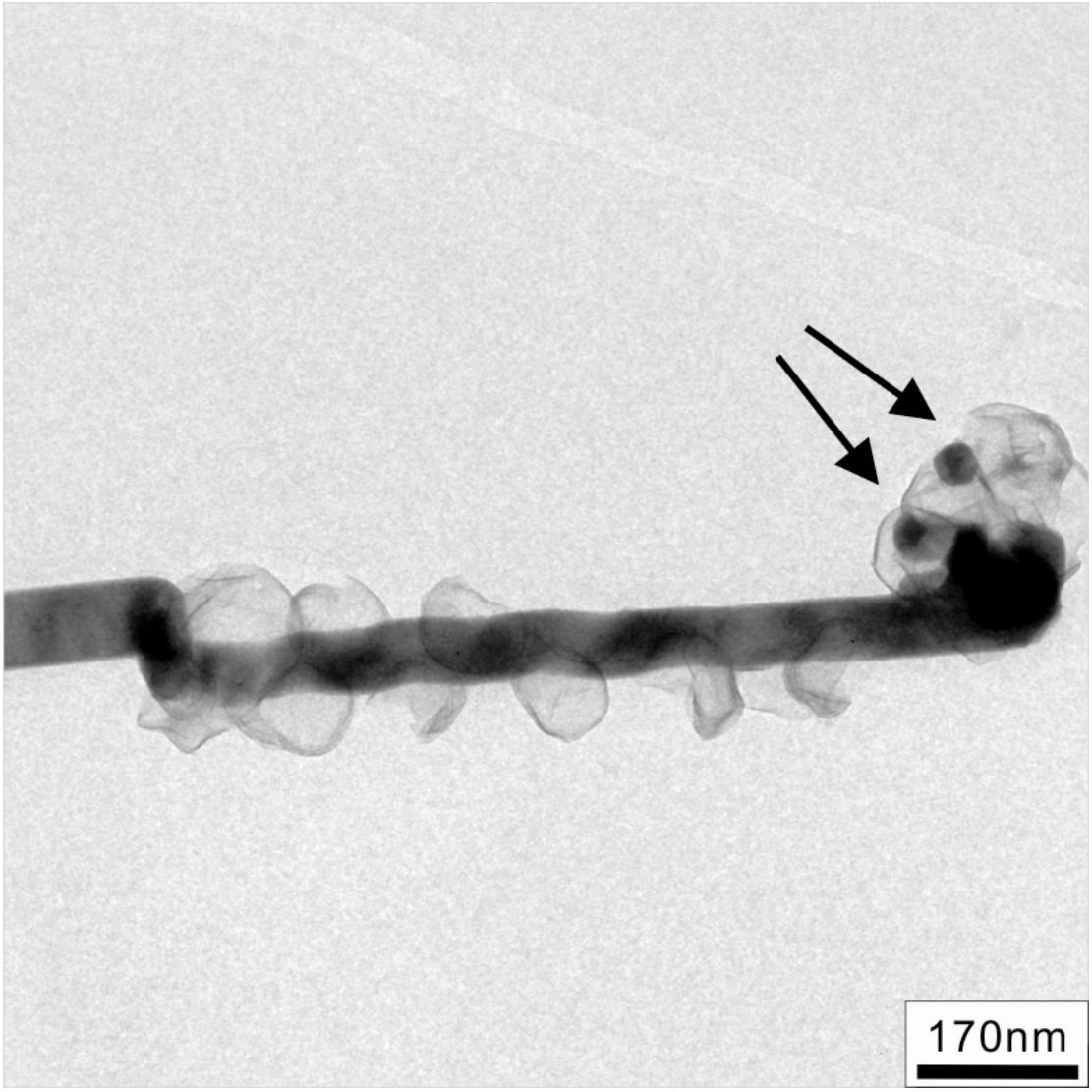

Figure S8. Au nanoparticles (arrow) left inside nanobubbles.

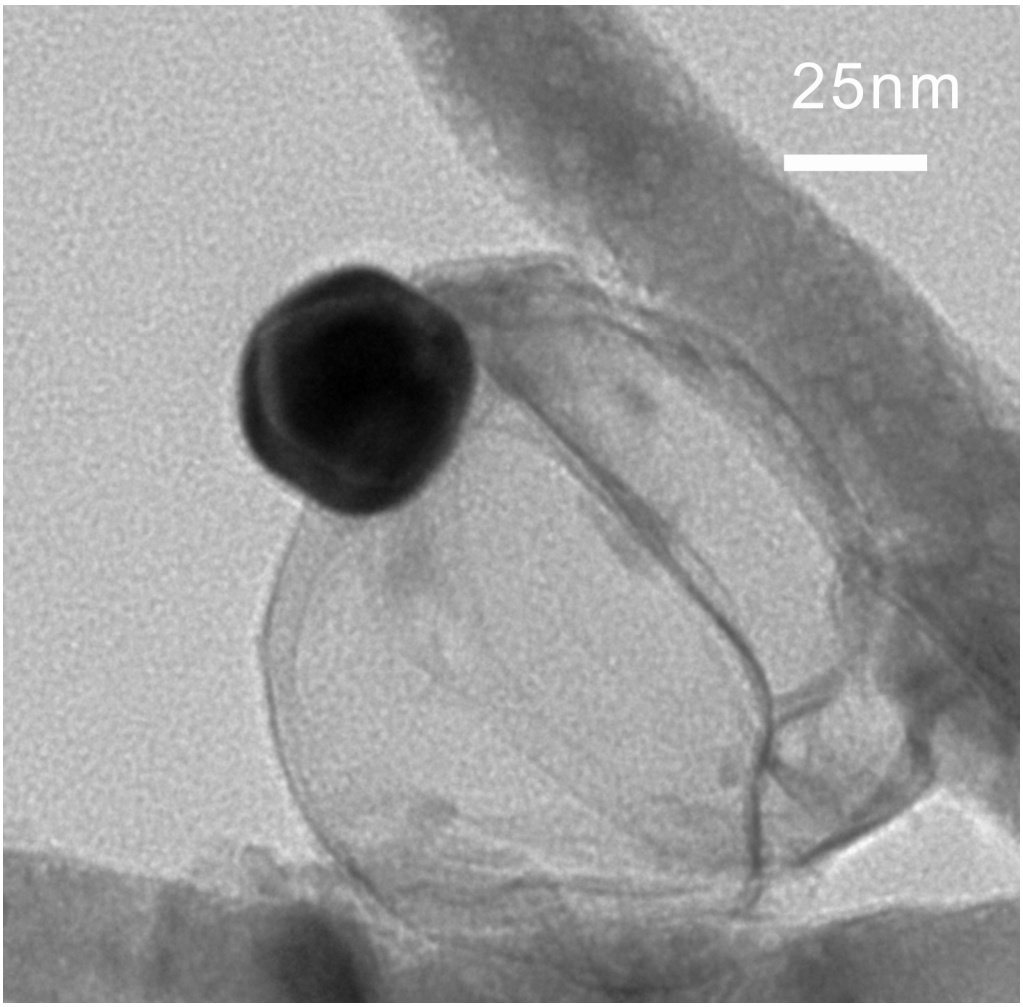

Figure S9. A small catalyst cap at the surface of a bubble that does not attach on a nanorod.

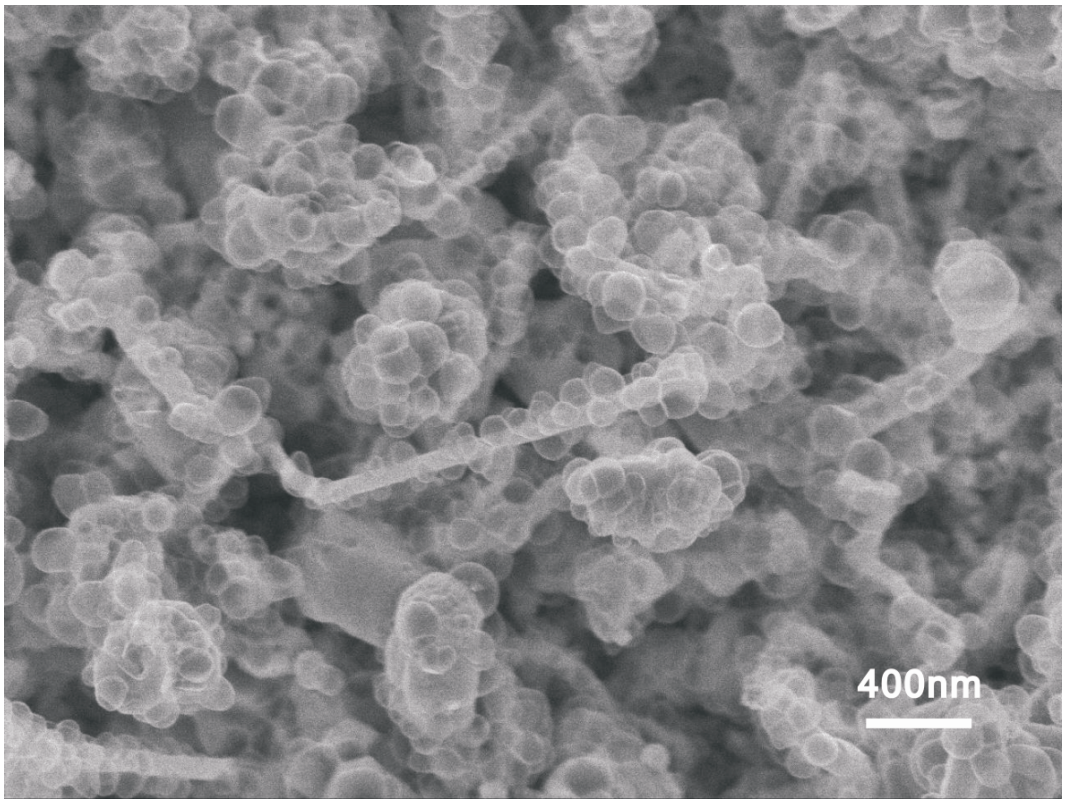

Figure S10. More and bigger bubbles (most bubbles diameters are larger than 130 nm, nearly 40 nm larger than those shown in the manuscript) were obtained when we reduced the quantity of In_2O_3 from the source as the other experimental conditions were unchanged.