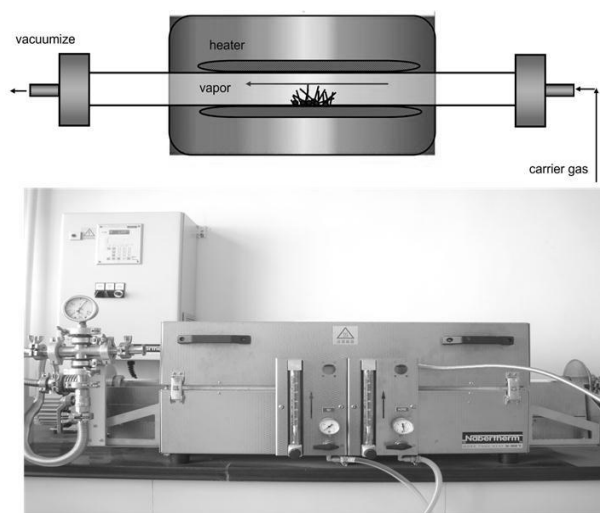


SUPPORTING INFORMATION:

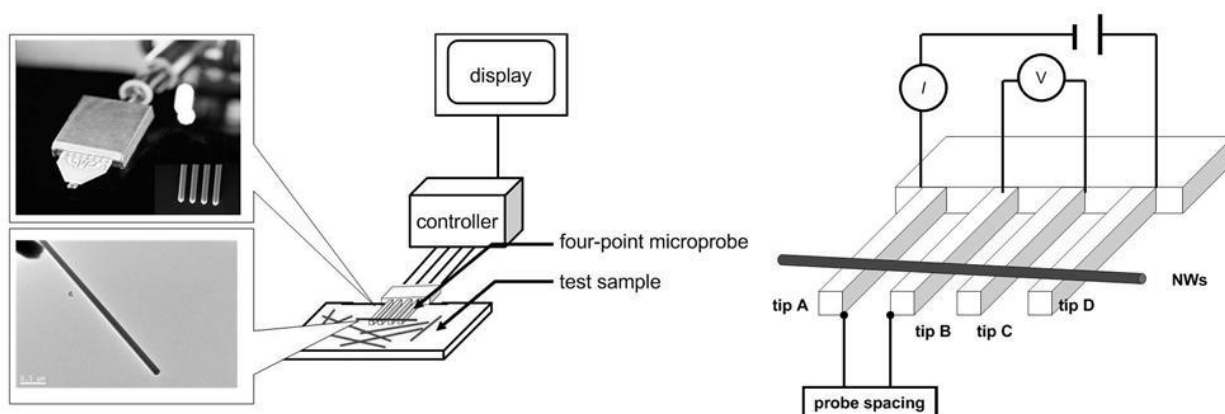
Experimental details:

A. Cu NWs via the ethylene glycol (EG) solvothermal reduction in the presence of PVP^[10]. 15 mL of freshly prepared $\text{Cu}(\text{NO}_3)_2 \cdot \text{H}_2\text{O}$ solution (0.435 g in EG) was injected into 30 mL of polyvinylpyrrolidone (PVP) solution (0.675 g in EG) prepared before at a rate of 45 mL/h with magnetic stirring. The mixture solution was then kept in a teflon-lined stainless steel autoclave of 150 mL capacity at a temperature of 160°C for 24 h. The brownish red precipitate was isolated by centrifugation at 4500 rpm, washed several times with distilled water and alcohol, the whole process of reaction in the protection of nitrogen and the nanowires obtained finally kept in ethanol at room temperature.

B. Electrical Measurement. Our experiments were performed in a STM equipped with a CAPRES A/S M4PP monolithic Microscopic Four-Point Probes serving as a manipulator. The reason is that four-terminal I-V measurements were done by sweeping the bias voltage between tips A and D with recording of the current flow I and the voltage drop V between tips B and C (Scheme SI-2). Voltage probes absorbed current less than 0.1 pA in these I-V measurements, which is negligibly small compared with the measurement current. They work under scanning electron microscope in ultra-high vacuum (UHV), enabling precise probe positioning on aimed areas on the Cu@c NWs surface. But the conductivity measurements can be done only at room temperature, which limits the physics we can discuss from the data. Nanowires was placed on top of the contacts to avoid mechanical deformation of the wires, resistances of the order of gigaohms were recorded.



Scheme SI-1. Schematic Illustration of the CVD Method for Preparing copper@carbon nanowires or core-shell structured nanowires.



Scheme SI-2. Scheme image shows around the voltage probes (tips A-D) touching on a NW and corresponding four-terminal I-V curves.

1. TEM, SEM characterization of copper nanowires synthesized via the ethylene glycol (EG) solvothermal reduction in the presence of PVP.

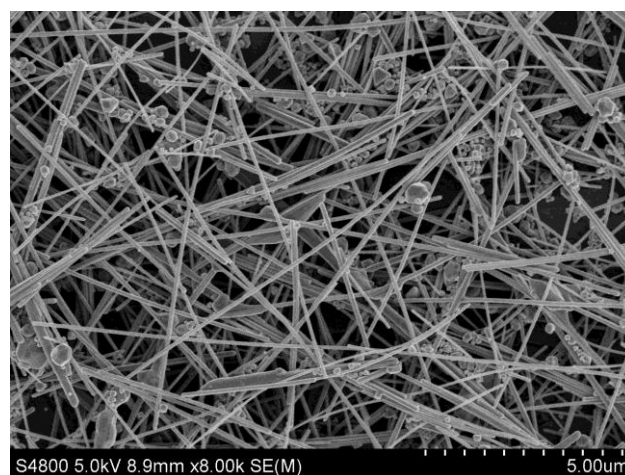


Figure SI-1. SEM images of copper nanowires synthesized by a polyol-thermal approach at 160°C for 24 h in the presence of PVP separated by centrifugation at 4500 rpm.

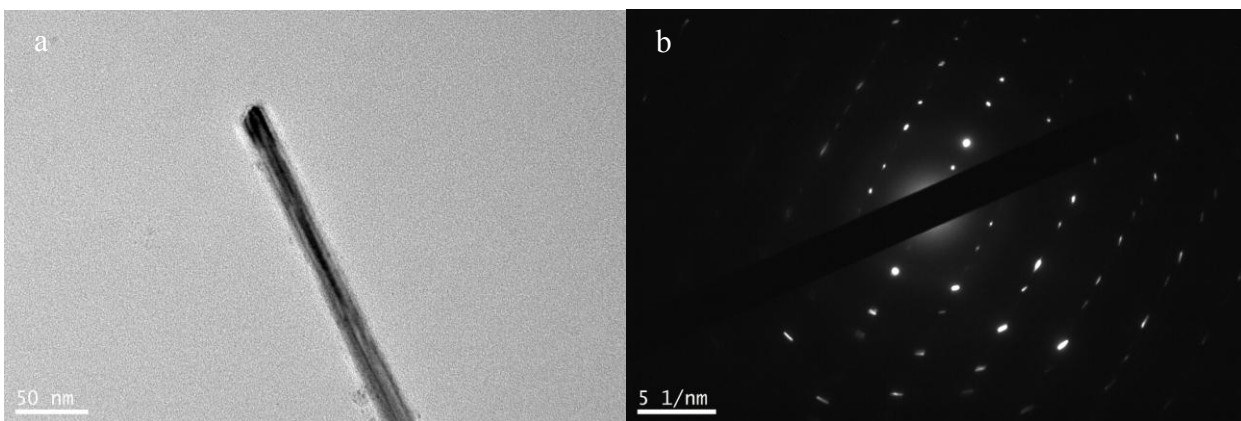


Figure SI-2. (a) TEM images of a single copper nanowires with the diameter of 20 nm or less and (b) SAED pattern corresponding to the same nanowire.

2. TEM, SEM characterization of the coproducts after above 800°C thermal treatment via the CVD method.

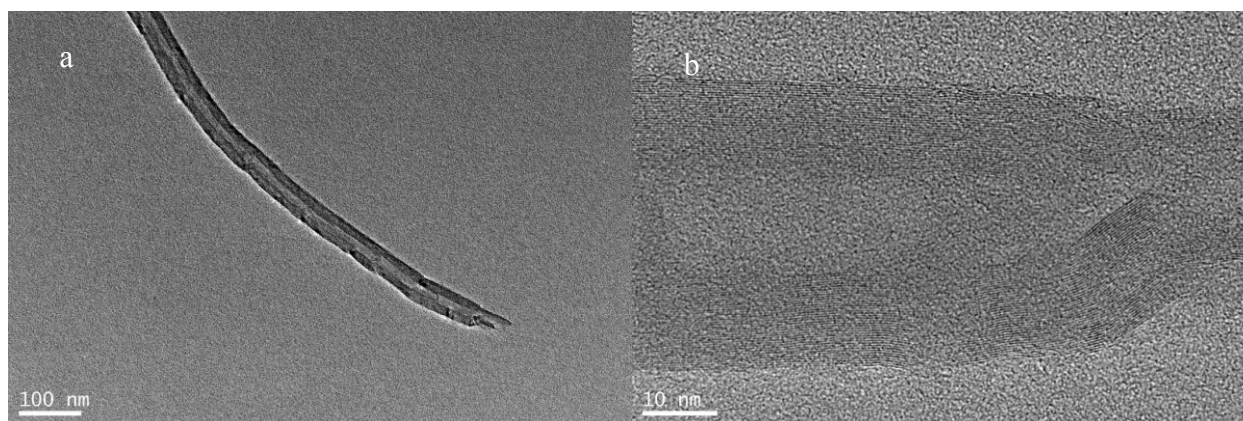
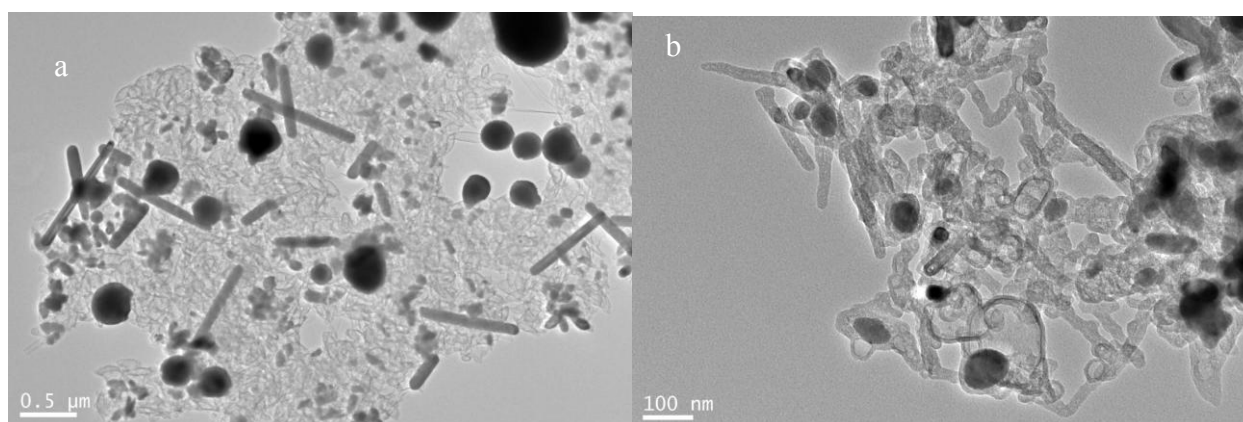


Figure SI-3. (a) TEM images of a single carbon nanotube with the diameter of 30 nm after total evaporation of copper core at 850°C for 3 h and (b) HRTEM image displays that this hollow tube have well crystallized multiple-graphite layers.



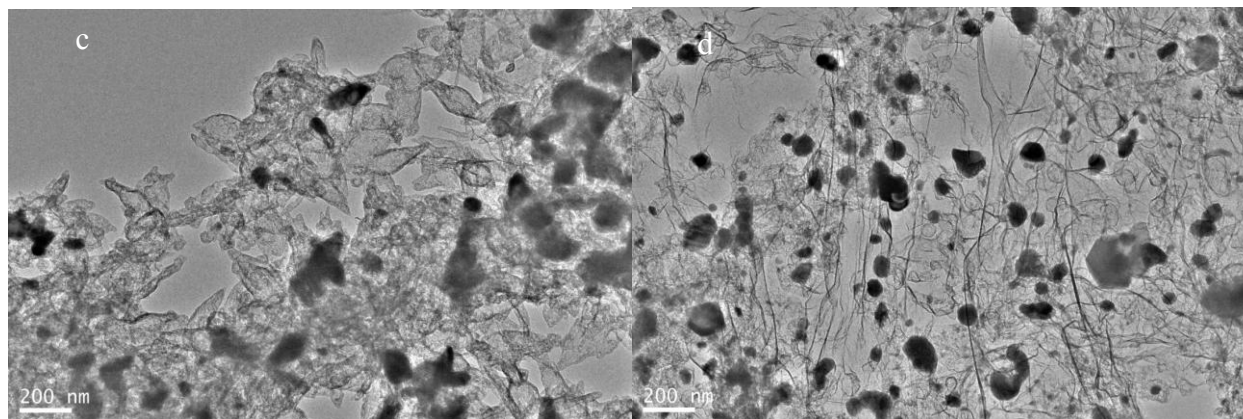


Figure SI-4. TEM images of final product after thermal treatment at 1000°C for various duration times: (a) 1 h, (b) 2 h, (c) 4 h, (d) 6 h, respectively. The nanostructures (copper core and carbon tubes) were all destroyed after the overheat.