Supplementary Materials

Functionalization of Silver Nanowire Surfaces with Copper Oxide for Surface-Enhanced Raman Spectroscopic Bio-Sensing

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Materials preparation: Ag NWs were prepared in a polyol solution with polyvinylpyrrolidone (PVP, K25, M.W.= 24000, Alfa Aesar) as a structure directing reagent using a method modified from the literature [1,2]. Ag NWs were washed in deionized (DI) water to remove the ethylene glycol and PVP and condensed by centrifugation. Copper substrates (99%, Arcor Electronics, Northbrook) were ultrasonically cleaned in acetone for 3 minutes to remove the organics, diluted in HNO_3 for 1 minute to remove the oxide layer and rinsed in ultrapure water (electrical resistivity approximately 18 MΩ·cm).

Characterization: Field-emission scanning electron microscope (LEO 1530 FE-SEM) was used to study the microstructure of samples. Micro X-ray Diffraction (XRD, Rigaku SA-HF3, Cu Kα, 1.54 Å) was employed for phase analysis. Microstructures and interfaces of functionalized Ag NWs were characterized using conventional transmission electron microscopy (TEM, PHILIPS CM12) and high resolution transmission electron microscopy (HRTEM, JEOL 2010F). SERS spectra were measured with a Renishaw micro-Raman spectrometer with 4.5 mW of laser radiation at an excitation wavelength of 488 nm and spectral resolution of 1 cm^{-1}. A 50x objective was used and the focal spot was about 5 μm.
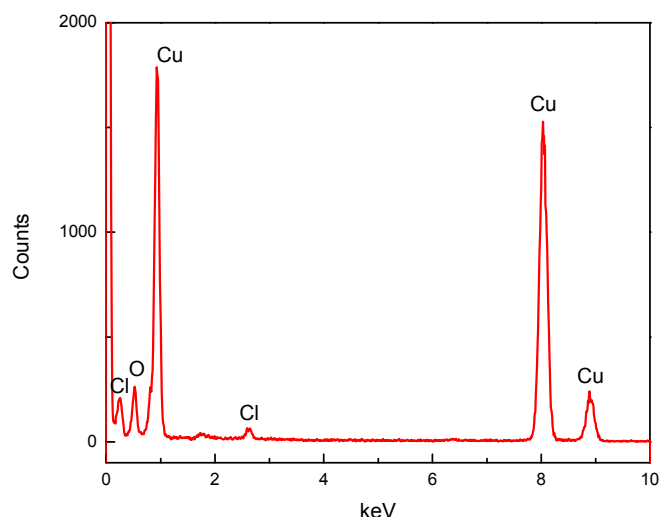
Figure S1. EDX results of nanoparticles, Cl was from the contamination during TEM sample preparation.

Average coverage and exposed interfacial area calculation: CuO was considered as cube-shaped nanoparticles and the average length of cube is 10 nm. If the nanoparticle size was large than 15 nm, it was considered as an overlapped site by two CuO nanopartciles. By counting CuO sites on unit length of Ag NW and measuring the diameter of Ag NW, Average coverage of CuO on Ag NW surface was calculated by the CuO-Ag contact area (10 nm × 10 nm for each cube) dividing by Ag NW surface area. For each CuO cube, the exposed interfacial area contains four CuO faces close to Ag surface ($4\times$ 10 nm$\times$ 10 nm). With the increasing of CuO on Ag surface, the overlapped CuO nanoparticles increased and could reduce the exposed interfacial area for each overlapped CuO site (each overlapped site would reduce three exposed CuO faces, $3\times$ 10 nm$\times$ 10 nm). Here, we assumed the overlapping is 50% of two cubes for A3, A4 and A5 as shown in Figure S2. The exposed interfacial area was calculated by reduced exposed interfacial area of CuO dividing by Ag surface area ($EIA = A_{CuO\text{-}Ag\ perimeter} / A_{Ag}$). The unit is nm^2 of CuO per nm^2 of Ag surface area. For A5, all the Ag surfaces were covered by CuO, there is no open Ag surface and the exposed interfacial area became to zero.
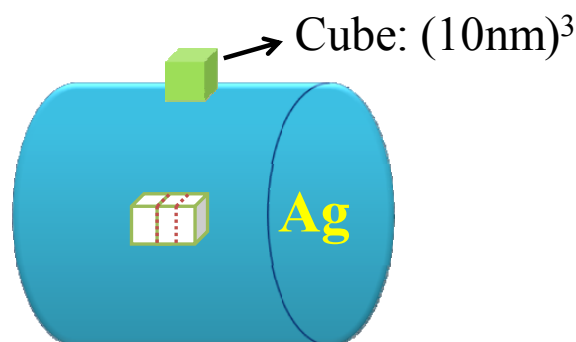

Cube: $(10nm)^3$

Ag

Figure S2. CuO cube and 50% overlapping configuration for average coverage and exposed interfacial area of CuO on Ag NW surface calculation.
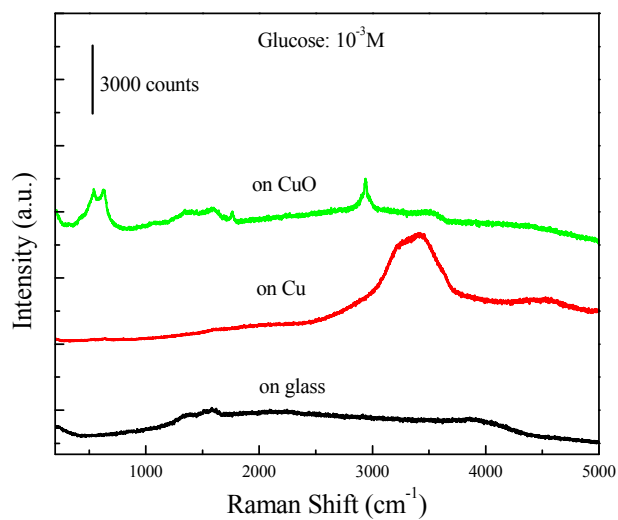
Figure S3. SERS spectra of D-glucose molecules with a concentration of 10^{-3} M obtained from the bare glass, copper substrates and CuO nanobelt powder.

[1] Sun, Y.; Gates, B.; Mayers, B.; Xia, Y. *Nano Lett.* **2002**, 2, 165-168.

[2] Sun, Y.; Xia, Y. *Adv. Mater.* **2002**, 14, 833-837.