

Supporting information

Transparent, conductive gold nanowire network assembled from soluble Au thiocyanate

Ahiud Morag,^a Vladimir Ezersky,^a Natalya Froumin,^a Dmitry Mogiliansky,^a Raz Jelinek^{a,b}

^a Ilse Katz institute for Nanotechnology and ^bDepartment of chemistry Ben Gurion University of the Negev, Beer Sheva 84105, Israel.

Fax: (+972)8-647-2943

E-mail: razj@bgu.ac.il

Experimental Details

Sample preparation:

1 mL of $\text{HAuCl}_4 \cdot 3\text{H}_2\text{O}$ dissolved in water (24 mg mL^{-1}) was added to 1 mL aqueous solution of KSCN (60 mg mL^{-1}). The precipitate formed was separated by centrifugation at 4000 g for 10 min in order to separate the complex from the solution which contains KCl and excess of KSCN. The precipitation was dried and dissolved in 2 mL of DMSO and water (4:1 v:v). The solution was left to incubate for 24 h after which 100 μL of solution was drop cast on a 1.0 cm * 2.5 cm, ozone exposed glass slide, and left to evaporate at room temperature. When the solvent was completely evaporated the glass was inserted into a plasma cleaner (PDC – 32G, Harrick Plasma) and the vacuum pump was turned on for 90 sec. Subsequently the sample was exposed to plasma for 3 min, at high RF (radio frequencies) and power of 18W, effectively reducing Au^{III} to Au^0 . After plasma treatment the glass was rinsed with water to remove surface aggregates.

Scanning electron microscopy (SEM):

For the SEM analysis 20 μL of a solution of $\text{KAu}(\text{SCN})_4$ (24 mg mL^{-1}) which was incubated in the DMSO/water mixture for 24 hours was drop-casted on a silicon piece ($2.5 \times 1.0 \text{ cm}^2$) and the solvent was left to evaporate at room temperature. SEM images were recorded on a JEOL JSM-7400F Scanning Electron Microscope (JEOL LTD, Tokyo, Japan) at an acceleration voltage of 3 kV.

TEM:

For TEM samples were prepared by scratching nanowires grown on glass onto 400-mesh copper formvar/carbon grids (Electron Microscope Sciences, Hatfield, PA, USA). HRTEM images were recorded on a 200 kV JEOL JEM-2100F equipped with Energy Dispersive X-Ray Spectrometer (JEOL, JED-2300T).

XPS:

X-ray photoelectron spectroscopy (XPS) analysis was carried out using Thermo Fisher ESCALAB 250 instrument with a basic pressure of $2 \cdot 10^{-9}$ mbar. The samples were irradiated in 2 different areas using monochromatic Al $K\alpha$, 1486.6 eV X-rays, using a beam size of 500 μm . The high energy resolution measurements were performed with pass energy of 20 eV. The core level binding energies of the Au4f peaks were normalized by setting the binding energy for the C1s at 284.8 eV.

XRD:

Powder x-ray diffraction (XRD) XRD patterns were obtained using Panalytical Empyrean Powder Diffractometer equipped with a parabolic mirror on incident beam

providing quasi-monochromatic Cu K α radiation ($\lambda=1.54059$ Å) and X'Celerator linear detector. Data were collected in the grazing geometry with constant incident beam angle equal to 1° in a 2θ range of 10-80° with a step equal to 0.05°.

Conductivity measurements:

100 μm square electrodes with distances of 100 μm and 1 mm spacing, respectively, composed of 10 nm Cr and 90 nm Au, were thermally evaporated on the glass substrate onto which the Au film was deposited. Room temperature conductivity measurements were carried out in a two – probe configuration using a probe – station equipped with a Keithley 2400 SMU. The conductivity data are an average of eight measurements performed for electrode pairs etched at different locations within the film.

Transmittance measurements:

UV-Vis transmittance measurements in the range of 300-900 nm were conducted on a Caria 5000, Varian Analytical Instruments, Melbourne.

Supporting Information Figures:

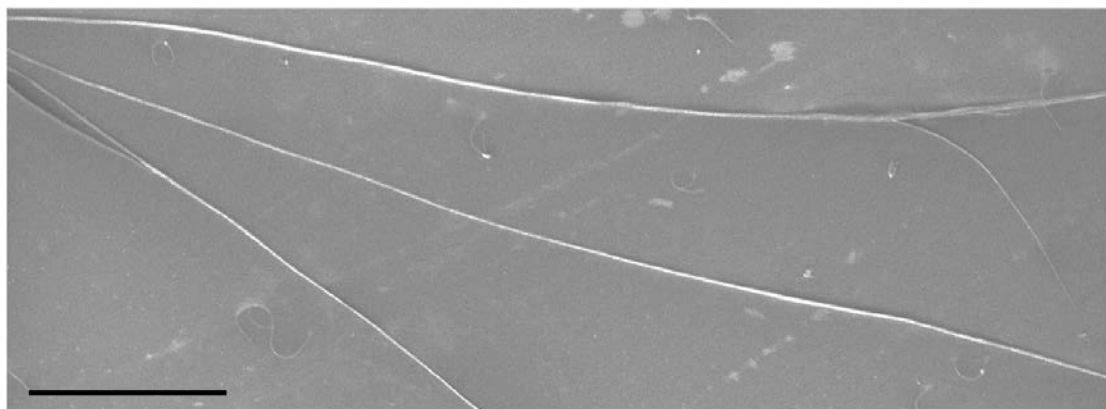


Figure 1,SI: Nanowires assembled following incubation of Au(SCN)4- in DMSO/water solution. SEM image of the nanowires deposited on glass substrate. Scale bar is 50 μm .

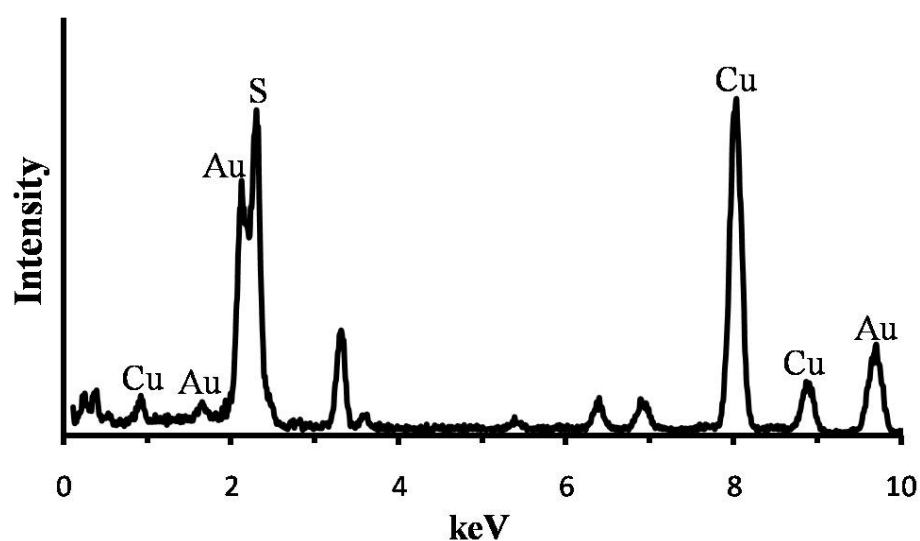


Figure 2,SI: EDS of a single Au nanowire. Average EDS showing a ratio of approximately 5:2 between the gold and the sulfur. The fact that this ratio is *smaller* than the 4:1 Au:S ratio in $\text{Au}(\text{SCN})_4^-$ indicates that the nanowire comprises of a mixture of Au(0) and Au(III).

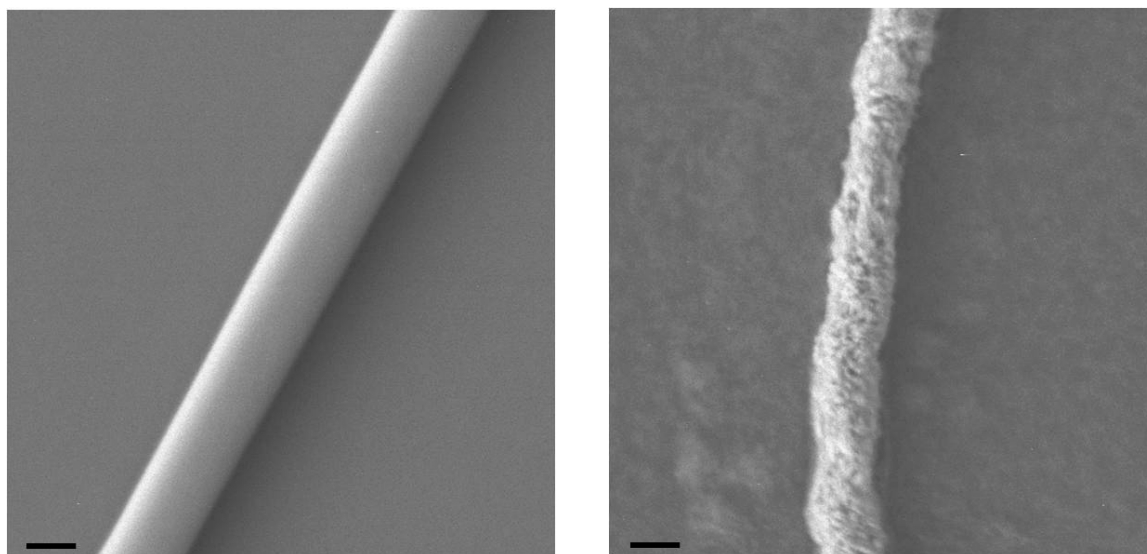


Figure 3,SI: Effect of plasma reduction on the nanowire surface. **Left:** smooth surface of the as-synthesized nanowire; **right:** coarse surface after plasma reduction. Scale bar: 200 nm.