

Supplementary Information for Generation and Controlled Routing of Single Plasmons on a Chip

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Silver Nanowire Fabrication

For preparation of silver nanowires, we applied a polyol reduction process for silver nitrate [1]. We purchased all the chemicals required for the preparation of silver nanowires from Sigma Aldrich. Below, we give a brief description of the procedure followed for synthesis of silver nanowires, and then we present some scanning electron microscope (SEM) images of the resulting silver nanowires.

Chemical Synthesization Process

5ml of Ethylene Glycol (EG) was put in a 25 ml Erlenmeyer flask with stopper, and heated to 151 °C with constant stirring at 260 rotations per minute (RPM). A magnetic stirrer combined with a hot plate was used for stirring and heating. A thermometer was attached to monitor the temperature during the reaction time. It is very important to keep the temperature as close as possible to 151 ± 1 °C , because the reaction is temperature sensitive. The temperature was controlled, and was kept close to 151 °C through the entire process. For this purpose, the flask was placed in an oil bath.

While the EG was heated, solutions of Cu (II) chloride dihydrate, silver nitrate and polyvinyl pyrrolidone (PVP) was prepared with the following concentrations:

- 2 mg of Cu(II) chloride dihydrate in 3 ml of EG
- 49 mg of PVP in 3 ml of EG
- 47.9 mg of silver nitrate in 3 ml of EG

After 1 hour, 40 μ L of copper chloride solution was added to the heated EG with the help of an electronic pipette. After waiting for 15 minutes, 1.5 ml of PVP solution was added. Immediately after that 1.5 ml of silver nitrate solution was also added. The reaction was then allowed to run for 1.5 hours.

During the reaction, the following color changes were observed:

- within 1 min yellow,
- within 3 min red orange,

- within 5 min dirty greenish, and a
- gradual shift from dirty green to brownish red.
- The end product after 1.5 hours was opaque grey.

Washing Process

Finally, the product obtained was washed by a centrifuge process. The product and an equal amount of acetone was added to the centrifuge tube and was subsequently shaken. The Centrifuge process was run at 3900 RPM for 30 minutes. It was observed after the process that silver particles were settled down. The liquid was removed by a pipette and the same process was repeated once more with acetone and then with distilled water. At the end, the product which settled down in the centrifuge tube (silver nanowires) was dispensed in distilled water for storage.

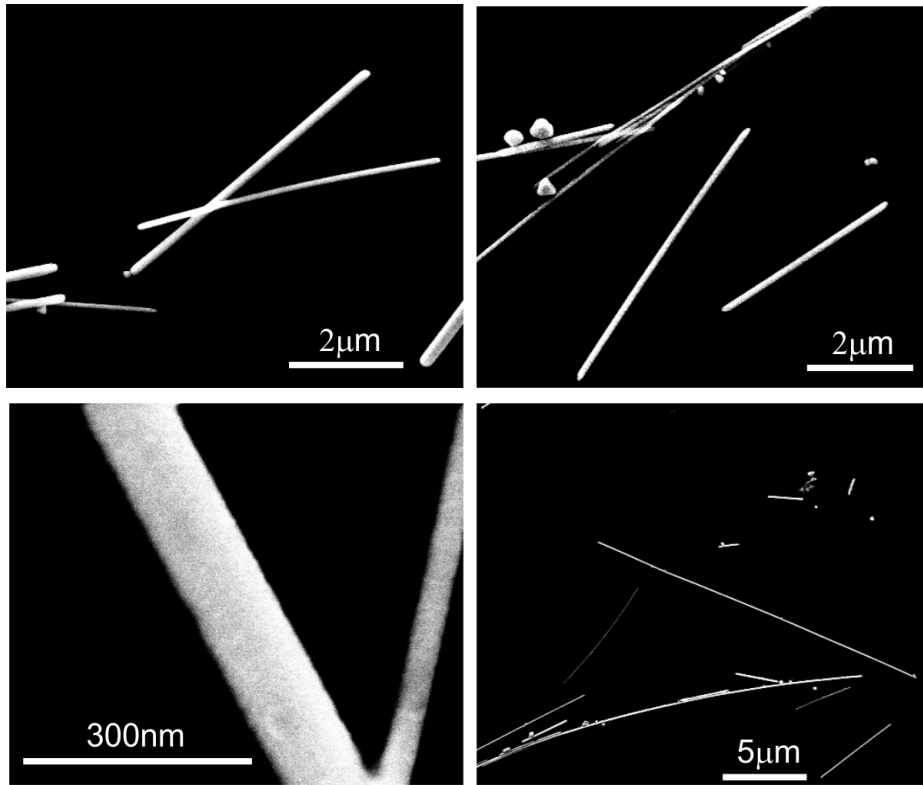


FIG. S1: SEM images of silver nanowires at different scales, for different nanowires.

SEM Images of Silver Nanowires

SEM images of some silver nanowires are shown in figure S1. It can be observed that silver nanowires obtained with the chemical synthesization process has a distribution over lengths and diameter. By changing the parameters of the chemical process, this distribution can be changed. We have made silver nanowires with the diameters ranging from 50 nm to 70 nm, and for another solution between 70 nm and 130 nm.

Cutting and Moving Silver Nanowires

The cutting and moving of the silver nanowires was done by using the cantilever tip of an atomic force microscope (AFM). To cut the wire, the AFM tip was pressed with a force of approximately 1 μN on the fused silica substrate in contact mode operation, and it was manually moved at high speed ($\approx 5 \mu\text{m/s}$) across the wire. The wire was then found cut. Then the lower part of the cut wire was moved slowly by touching the wire on its sides at 10-12 different points in contact mode operation. The contact force between the substrate surface and the AFM tip, when moving the wire, was kept 10 times smaller compared to when the wire was cut. Because the thin silver wires are fragile, in each step, the wire was moved by approximately 0.1 μm . After every step of the wire movement the system was scanned with the AFM in tapping mode operation to make an image of the sample.

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- [1] Kylee E. Korte, Sara E. Skrabalak, and Younan Xia. Rapid synthesis of silver nanowires through a CuCl - or CuCl_2 -mediated polyol process. *J. Mater. Chem.*, 18(4):437–441, 2008.