Electrochemical growth of individually addressable palladium nanowires.

M. A. Bangar[1], K. Ramanathan[1], M. Yun[2], W. Chen[1], A. Mulchandani[1,], N. V. Myung[1,3,*]

[1]Department of Chemical and Environmental Engineering
[3] Center for Nanoscale Science and Engineering
University of California, Riverside
Riverside, CA 92521.

[2]Jet Propulsion Laboratory
California Institute of Technology
Pasadena, CA 91109.

Abstract:

The interest in identifying multitude of chemical compounds with high sensitivity and selectivity requires high-density nano electronic sensor using nano-structures like nanowires. Recently we have developed a facile technique of fabricating individually addressable nanowires.[1] This technique of electrodeposition within e-beam lithographically patterned electrolyte channels, offers a simple and cost effective method to fabricate nanowires in a single step at ambient temperature and pressure with dimensional control and the ability to address individual nanowire in an array.

Using this technique, growth and confinement of individual conducting polymer[2] and palladium nanowire between gold electrodes has been achieved within nano channels on silicon wafers. The Pd nanowires were electrochemically grown using a Pd p-salt solution and monitored electrochemically using a chronopotentiometric recording (Figure 1). The formation of the nanowire was indicated by a rapid change in the resistance between the gold electrodes.

The channels were prefabricated on a silicon wafer using photolithographic patterning and the channel dimensions were varied from 100 nm to 1 μm. Several variables influencing the growth of the nanowire such as current density, channel width, solution concentration has been optimized. The presence of the nanowire was confirmed using optical imaging, scanning electron microscopy (Figure 2) and electrical measurements. From the current versus voltage (I-V) response, ohmic contact of the nanowire is confirmed with the resistance being inversely proportional to the diameter of the nanowire (Figure 3).

The mechanism of growth of such metallic nanowires and their application to multi-analyte detection systems is being investigated.

Reference:

1. Yun, M.; Myung, N. V.; Vasquez, R. P.; Menke, E.; Penner, R. M. *Nano Lett.* **2004,** *4*(3), 419.
2. Ramanathan, K.; Bangar, M. A.; Yun, M.; Chen, W.; Mulchandani, A.; Myung, N. V. *Nano Lett.* **2004** (in press)**.**

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* Corresponding author: myung@engr.ucr.edu

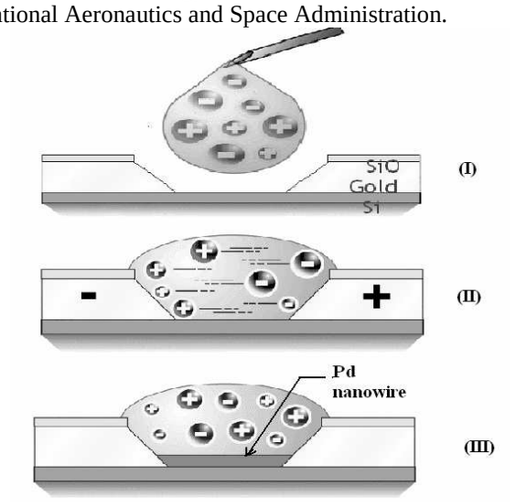

Figure 1. The process of electrodeposition: (I) Drop of electrolyte solution of palladium p-salt is placed on the e-beam patterned electrolyte channel, (II) diffusion of the solution into the channel establishing electrical contact between the gold electrodes and (III) electrodeposition of palladium nanowire from cathode to anode.

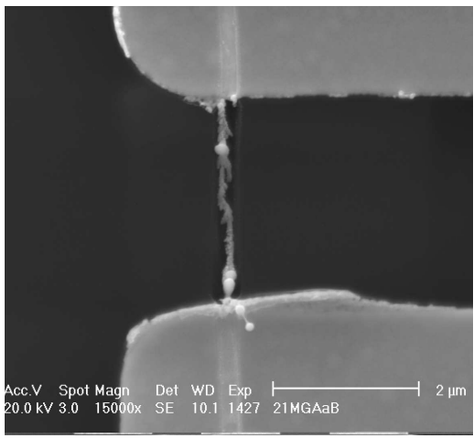

Figure 2. SEM image of electrochemically-grown single palladium nanowire with diameter of <100 nm and approximately 2.5 micron long.

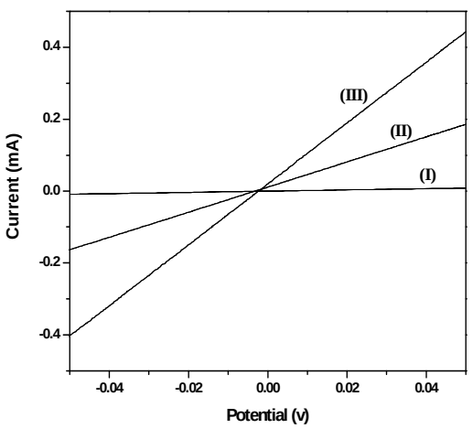

Figure 3: I-V characteristic of palladium wires grown in channels of 100 nm (I) 500 nm (II) and 1μm (III) widths under dry condition.