11th International Conference on Advanced Materials

Rio de Janeiro Brazil
September 20 - 25

ICAM 2009

Atomic Force Microscope Direct Write of Inorganic Nanowires

M. Rolandi(1)*, J. Torrey(1), S. Vasko(1),(2) and P. Morse(1),(3)

(1) Department of Materials Science and Engineering, University of Washington, Seattle, WA (USA)
(2) Department of Chemistry, University of Washington, Seattle, WA (USA)
(3) Department of Physics, University of Washington, Seattle, WA (USA)
* Corresponding author.

Abstract – Atomic force microscope high field lithography affords the direct write of germanium-based nanowires with nanometer control. Nanowires can be easily integrated into devices for the facile manufacturing of nanometer scale electronic components.

Facile integration of novel nanoscale devices requires manufacturing methods that afford exquisite control over the size, shape, and placement of the components. The tip of an atomic force microscope (AFM) can be positioned with sub nanometer precision and it defines a unique nanoscale environment[1] on the sample where highly localized chemical reactions can occur. This localization effect can be exploited to design additive nanomanufacturing processes that merge lithography and synthesis in a single step. Recently, the direct write of carbon-based etch resistant nanowires from high field AFM lithography in organic precursors (Fig. 1) has demonstrated structures as small as 2 nm[2] and patterning velocities as high as 1cm/s.[3]

This work expands the scope of the high field AFM direct write technique to the manufacturing of inorganic nanostructures. In brief, a biased AFM tip traces desired patterns on the silicon substrate while immersed in diphenylgermane. The electric field (*ca.* 10^9 V/m) induced in the small gap between the tip and the surface activates the precursor that deposits onto the substrate as germanium-based nanowires (Fig. 2). The chemical composition of the features was elucidated using time-of-flight secondary ion mass spectroscopy (Fig. 3) and x-ray photoemission electron microscopy. The data suggests that the wires are mainly composed of germanium without any detectable carbon contamination originating from the precursor. In this fashion, semiconductor-based nanostructures can be precisely positioned on the substrate for facile integration into devices; potential applications include computing and sensing.

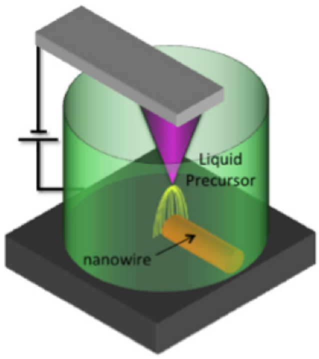

Figure 1: Schematic of setup for AFM high-field direct write

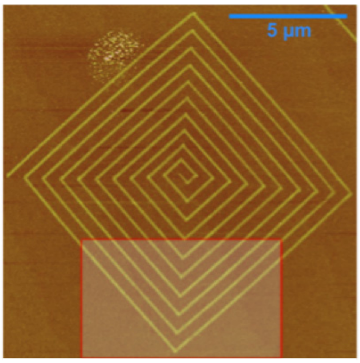

Figure 2: AFM micrograph of Ge-based nanowires written using diphenylgermane as precursor.

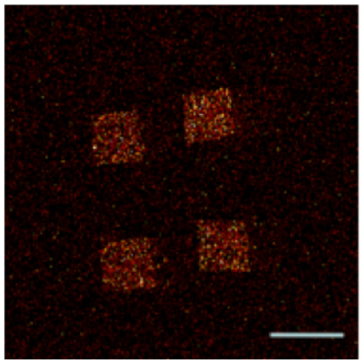

Figure 3: SIMS ion count for Ge (mass 70) from microscopic patterns fabricated using diphenylgermane precursor. Scale bar 20µm.

References

[1] R. Garcia, R. V. Martinez, J. Martinez, *Chemical Society Reviews* **2006**, *35*, 29.
[2] R. V. Martinez, N. S. Losilla, J. Martinez, Y. Huttel, R. Garcia, *Nano Letters* **2007**, *7*, 1846.
[3] M. Rolandi, I. Suez, A. Scholl, J. M. J. Frechet, *Angewandte Chemie-International Edition* **2007**, *46*, 7477.