Suspending Nanowires

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UCORE

INTRODUCTION

Nanowires may play an important role in future computing devices. To study the electrical and thermal properties of a certain nanowire, without interference due to direct contact with a substrate, it may be necessary to suspend the nanowire between contacts made from a highly conductive metal, such as gold. We attempted one method[1] for nanowire suspension which utilizes electron beam lithography and a sacrificial layer of resist in order to test its reproducibility and to optimize the parameters involved for use in future experiments.

[1]G. Kim, G. Gu, U. Waizmann, S. Roth, *Simple Method to Prepare Individual Suspended Nanofibers* (Applied Physics Letters, Vol. 80 No. 10, March 2002)

METHODS

-An array of gold contact pads, called a shadow mask, is created on a silicon substrate using a TEM grid and gold evaporation

-A coordinate pattern is created in the gaps of the shadow mask using electron beam lithography (EBL) with a single layer of electron beam resist (5% PMMA), followed by development of the exposed resist, gold evaporation, and liftoff of the resist

- A layer of PMMA is spun and the nanowires are deposited on the surface

- The nanowires (InAs) are imaged using an optical microscope

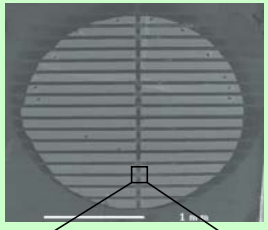
- Two more layers of PMMA are coated

-The coordinate pattern design is overlaid onto the optical microscope images and the trenches are designed

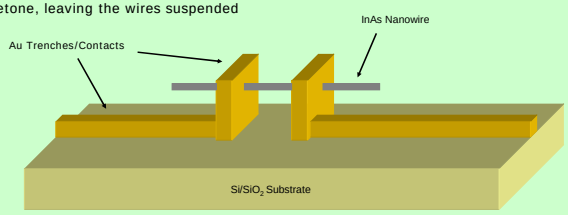
- The trench patterns are written in the resist using electron beam lithography

-The exposed resist is developed with a weak solvent (MIBK) and gold is evaporated into the trenches while the sample is tilted 30 degrees and rotated at 100 rpm

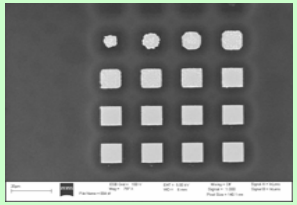
-- The remaining resist is removed with acetone, leaving the wires suspended



Nanowire Cluster



RESULTS

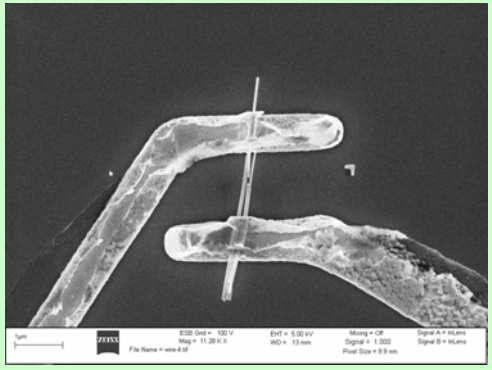


In order to determine the dose needed during the electron beam lithography, we exposed three PMMA layers to doses ranging from 200 – 580 uC/cm^2.

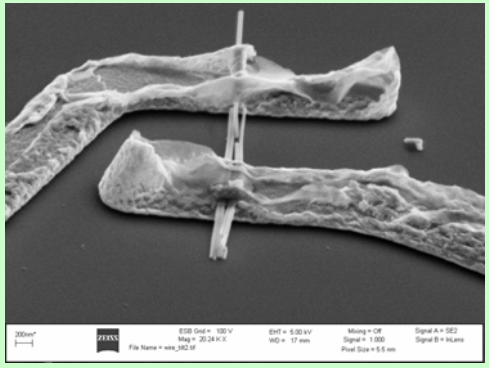
We concluded that an optimal electron beam dose for a three layer coating of 5% 950 molecular weight PMMA is 440 uC/cm^2.

We were successful in suspending multiple-wire clusters but were unsuccessful in suspending individual wires:

Top View

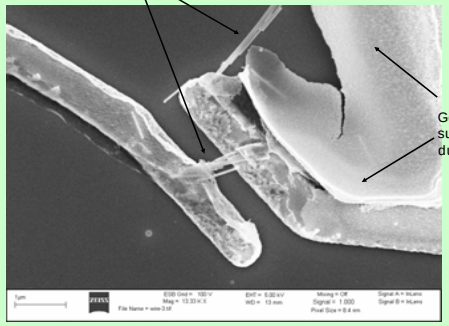


Tilted 60 degrees



(continued)

Nanowire clusters



Gold that was not successfully removed during liftoff

CONCLUSION

This method has proven successful for suspending nanowires. With further optimization and improvements to the procedure, it should be an effective method to suspend individual nanowires for testing.

FUTURE DIRECTIONS

- Use of SiO2 coated substrate to serve as an insulator for nanowire testing

- Testing of thermal and electrical properties of nanowires

- Design of a different contact pad structure to allow testing of different properties of the same wire

-Testing of oxygen plasma etching method to remove PMMA

-Improved optical imaging of wire distribution and location

- Testing of different evaporation angles and rates

- Testing of double-layer PMMA coatings

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