Sample Preparation Guide

Fusion™

Preparing One-Dimensional Nanostructures on Fusion E-chips™

Nanostructures are grown via a variety of methods. They can be grown on flat substrates such as a silicon or sapphire wafer as an ordered or disordered forest, or grown on disordered substrates. There are several possible methods to transfer nanowires from their growth substrate to the thin membrane on an Fusion E-chip. These methods serve as a guide when preparing nanostructure samples; other nanostructure sample preparation methods may be possible.

Method 1

The Sonication Method

1. Place a small section of the substrate and nanowires into a small vial or centrifuge tube. Fill the vial or tube with clean liquid such as ethanol.
2. Place the vial or tube in a sonicator for 5-30 seconds. The time will depend on the power of the sonicator and the type of sample.
3. After sonication nanostuctures should be free from the substrate and in suspension. Take a small amount of the suspension out with a pipette, ideally just a few micro liters.
4. Place a droplet of suspension on the E-chip just next to the membrane, and allow the liquid to spread over it. The liquid may go over the entire E-chip, but this is not a problem if the copper/beryllium contact pins are cleaned regularly. See the Fusion user guide for instructions on how to clean these pins.
5. Allow the liquid to dry. Drying can be accelerated by gently blowing nitrogen or clean air over the E-chip, by placing it in a vacuum chamber or under a heat lamp.

Method 2

The Scrape Method

This method is ideal for nanowires grown on hard, flat substrates, e.g. silicon or sapphire wafers.

1. Place a small drop of liquid such as ethanol onto the surface on which the nanowires were grown.
2. Gently scrape the surface with tweezers or a razor blade. This should free some nanowires into the liquid making a suspension.
3. One of two methods can be used at this point.
   a. Take a pipette and draw up some of the liquid and drop it onto the surface of the E-chip, as described in the "Sonication Method" section above.
   b. Pick up an E-chip with tweezers. While grasping it with the tweezers, flip the E-chip over so that the membrane side is facing down, and gently contact it to the small droplet on the surface of the sample substrate.
4. Use a Kim-wipe or sanitary tissue to gently blot excess liquid. Carefully touch a corner of the tissue to the liquid, and the liquid will wick into the tissue.
5. Allow the liquid to dry. Drying can be accelerated by gently blowing nitrogen or clean air over the E-chip, by placing it in a vacuum chamber or under a heat lamp.

Method 3

FIB Pick and Place

A third method uses a focused ion beam and micromanipulator system to "pick and place" individual nanowires, or groups of nanowires onto the membrane of an E-chip.

1. Bring the tip of the micromanipulator tool into contact with an individual nanowire.
2. Using a metal deposition system, weld the tip to the selected nanowire.
3. Cut the base of the nanowire with the ion beam.
4. The nanowire is now free from the substrate and can be transferred to the membrane on the E-chip.
5. Place the nanowire on the membrane in the desired spot. Static forces will be sufficient to hold it to the membrane, but welding the free end can also anchor it to the membrane.
6. Cut the nanowire free from the micromanipulator tip.

Note: *At high temperatures the deposited metal forming the anchor point may melt, however the nanowire should remained fixed to the membrane. Alternatively, W can be used for high temperature heating experiments. Please keep this in mind when doing heating experiments.*

If a FIB tool is not available, users can use "Method 1 or 2" to deposit nanowires randomly onto the E-chip membrane. When preparing nanowire samples for electrical measurements, nanowires can be strategically placed using "Method 3". Electrical contact can be made with FIB deposited metal. Electrical contact can be made using electron beam lithography or via other masking techniques.

Protochips