NANOFIBER STRUCTURES FOR MOLECULAR ASSEMBLY AND CONTROLLED TRANSPORT

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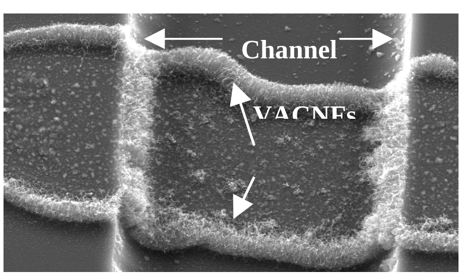
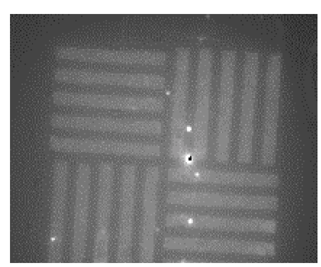
We are investigating the use of vertically aligned carbon nanofibers (VACNFs) as a material for both further assembly of higher order structures and for control of fluidic transport. Electron-beam (E-beam) lithography is used in combination with catalytically controlled growth to direct the self-assembly of the VACNFs. Large arrays of VACNFs can be designed and constructed with a feature size currently on the scale of a few tens of nanometers. These nanoscale arrays are grown using a plasma enhanced chemical vapor deposition (PECVD) process with the growth being initiated from a patterned array of metal catalyst particles. The VACNFs grow aligned with the direction of the plasma discharge, perpendicular to the substrate. The VACNF position, diameter (determined by catalyst nanoparticle size), and length (determined by growth time), all are under control. Therefore, this is a very powerful, directed self-assembly method with only one lithography step (catalyst definition). We are exploiting this first level of molecule scale assembly to address the construction of more complex multi-component structures. Investigations into chemical derivatization of the VACNFs will be presented. These efforts have focused on attaching biomolecules, such as DNA, to the sides of the VACNFs. Characterization of the chemistry has been through fluorescent microscopy and transmission electron microscopy. In parallel, we are also investigating the use of dense arrays of carbon nanofibers to control the fluidic transport of molecular species. Molecular transport, perpendicular to the orientation of the fibers, can be restricted based on the wall to wall spacing of the individual fibers. Therefore, semi-permeable membranes can be engineered from the directed self-assembly of VACNFs. Initial demonstrations of controlled transport, using VACNF barriers in channel structures, will be presented.



Example of VACNF’s grown in a channel structure.



Fluorescent microscope image of fluorescently labeled stripes of VACNFs.