NANO HIGHLIGHT

Nanotube based structures for high resolution control of thermal transport

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The ability to control heat transfer on small time and length scales would have a significant impact in many areas. For example, in just three applications: thermoelectric micro-coolers, DNA amplification via Polymerase Chain Reaction (PCR) and harvesting waste heat to do work on the microscale, this capability would immediately improve the performance of these devices. To be able to control heat transfer to thermoelectric coolers, micromachined PCR devices and micro heat engines a type of thermal switch or thermal valve is required. Such a thermal switch would be able to change its effective thermal conductivity in order to turn heat transfer on and off.

In this work we incorporate carbon nanotubes into microscale composites to create a new kind of mesoscale device, a thermal switch. Arrays of thermal switches will then be produced in batch to create sheets with spatially and temporally controllable "digital" thermal conductivity. Carbon nanotubes (CNT's) bridge scales from nanometers to micrometers, and MEMS techniques bridge scales from micrometers to millimeters. Manufacturing across six orders of length scales from nano to meso is made possible by utilizing the mixed-scale architectures of high aspect ratio CNT's and two-dimensional lithographic-based low-aspect ratio MEMS fabrication techniques.

Using lithographically-based fabrication techniques, we manufacture meso-scale devices with spatially and temporally controllable "digital" thermal conductivity. Individual CNT composite blocks will be distributed across a silicon wafer, and aligned opposite an array of thin membranes. Making and breaking contact between the high thermal conductivity CNT composite blocks will enable the thermal conductivity through the device to be changed and controlled at will.

We have successfully patterned and grown CNT's on silicon substrates to create vertically aligned carbon nanotube turf or VACNT turf as shown in figure 1.

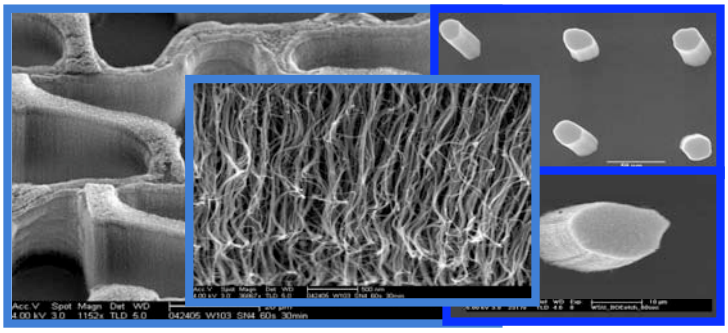

Fig. 1 Patterned vertically aligned carbon nanotube turf.

References

[1] For further information about this project link to **<http://www.mme.wsu.edu/~ThermalSwitch>** or email **<cill@wsu.edu>**

[2] D. McClain, L.F. Dong, C.C. Pan, J. Jiao, C. McCarter, D. Bahr, C. Richards, R. Richards, "Synthesis and Microanalysis of Aligned Carbon Nanotube Arrays," *Proceedings of Microscopy and Microanalysis 2005,* Vol. 11, Supplement 2, 1920-1921 (2005).