Abstract Submitted
for the MAR09 Meeting of
The American Physical Society

Manufacturing thin films of densely packed horizontally aligned carbon nanotubes SAMEH TAWFICK, A. JOHN HART, University of Michigan — Dense packing of carbon nanotubes (CNTs) over long-range dimensions is necessary to replicate their outstanding properties in functional thin films. We present a continuous method for transforming pillars of vertically aligned (VA) CNTs into densely packed, horizontally aligned (HA) CNT ribbons and sheets, which can be directly used on wafer-scale dimensions and/or patterned by photolithography and plasma etching to achieve feature dimensions down to the micron scale. In this process, a small roller is used to "topple" millimeter-tall VA-CNT microstructures and to simultaneously compress them, thus increasing the packing fraction of CNTs from 2% to 60%. We formulate design guidelines for selection of pattern geometry, roller diameter and material, and the kinetics of the rolling motion. This enables precise control of the HA-CNT film topography and thickness, and the packing density and orientation of the CNTs. Nanoindentation of the HA-CNT films reveals that the initial tortuosity of the VA-CNT forest determines the ultimate achievable densification. Electrical conductivity of ribbons is characterized using dc-four-point testing of lithographically-patterned CNT ribbons with Au contacts. The HA-CNT structures are easily transferred to other substrates, enabling integration with CMOS and MEMS fabrication, and with alternative substrates such as flexible plastics.

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Date submitted: 21 Nov 2008 Electronic form version 1.4