Electrostatic Actuation and Electromechanical Switching Behavior of One-Dimensional Nanostructures

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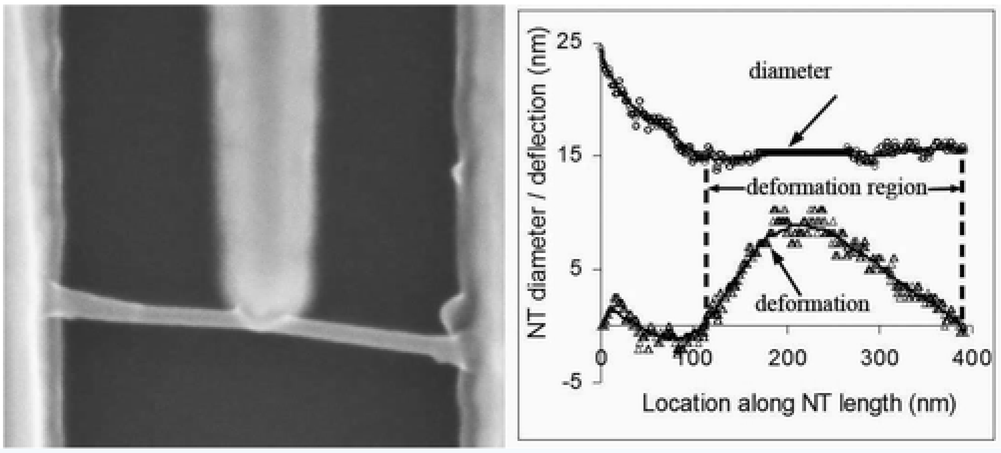
Abstract



We report on the electromechanical actuation and switching performance of nanoconstructs involving doubly clamped, individual multiwalled carbon nanotubes. Batch-fabricated, three-state switches with low ON-state voltages (6.7 V average) are demonstrated. A nanoassembly architecture that permits individual probing of one device at a time without crosstalk from other nanotubes, which are originally assembled in parallel, is presented. Experimental investigations into device performance metrics such as hysteresis, repeatability and failure modes are presented. Furthermore, current-driven shell etching is demonstrated as a tool to tune the nanomechanical clamping configuration, stiffness, and actuation voltage of fabricated devices. Computational models, which take into account the nonlinearities induced by stress-stiffening of 1-D nanowires at large deformations, are presented. Apart from providing accurate estimates of device performance, these models provide new insights into the extension of stable travel range in electrostatically actuated nanowire-based constructs as compared to their microscale counterparts.