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Carbon Nanotube Growth Under Applied Pressure: Mechanical Energy Output and Control of Film Structure A.J. HART, A. SLOCUM, Dept. of Mechanical Engr., MIT — We measure the force which can be exerted by a film of vertically-aligned carbon nanotubes (CNTs) as it grows by thermal CVD. The thickness of the film measured after a growth duration of 15 minutes decreases in an approximately linear fashion with the logarithm of pressure which is applied by placing a tungsten weight on the substrate prior to growth. With increasing pressure, the internal structure of the film changes from well-aligned, to less-aligned with bending and possible single-mode buckling of the CNTs, to predominately collapsed in an "accordion" pattern having a spatial wavelength of 0.1-1 μm. While the mechanical energy exerted is significantly less than major energetic steps in the growth reaction, a growing CNT film can lift tens of thousands of times its own weight. The equivalent volumetric energy density of 2.4×10^4 J/m^3 is comparable to muscle. We utilize this principle to fabricate CNT structures which grow to conform to the shape of an etched silicon template, which is clamped against the growth substrate. This technique surpasses traditional methods using two-dimensional catalyst patterns, as it enables fabrication of CNT structures having arbitrarily sloped surfaces, and does not require catalyst patterning. CNT films and structures having controlled density and conformation, such as fabricated by changing the pressure applied during growth, will be useful for applications including electrochemical energy storage and fluid filtration, and as scaffolds for biological materials.

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