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**Working cycles of devices based on bistable carbon nanotubes**  
OLEG SHKLYAEV, ERIC MOCKENSTURM, VINCENT CRESPI, Penn State University, CARBON NANOTUBES COLLABORATION — Shape-changing nanotubes are an example of variable-shape sp<sup>2</sup> carbon-based systems where the competition between strain and surface energies can be moderated by an externally controllable stimuli such as applied voltage, temperature, or pressure of gas encapsulated inside the tube. Using any of these stimuli one can transition a bistable carbon nanotube between the collapsed and inflated states and thus perform mechanical work. During the working cycle of such a device, energy from an electric or heat source is transferred to mechanical energy. Combinations of these stimuli allow the system to convert energy between different sources using the bistable shape-changing tube as a mediator. For example, coupling a bistable carbon nanotube to the heat and charge reservoirs can enable energy transfer between heat and electric forms. The developed theory can be extended to other nano-systems which change configurations in response to external stimuli.

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