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Generating electricity from yarn twist

Mechanical energy harvesters are needed for diverse applications, including self-powered wireless sensors, structural and human health monitoring systems, and the extraction of energy from ocean waves. Harvesters based on rubber dielectrics that change capacitance when strained can directly convert deformation into electricity, but typically require high voltages and additional circuitry to apply a bias voltage. In contrast, we present a new type of carbon nanotube yarn harvester that converts tensile or torsional mechanical energy into electrical energy, without requiring these large voltages or an external bias. When deformed in an electrochemical cell, these nanotube yarn harvesters produce electricity by changing double-layer capacitance. Stretching coiled yarn generated 250 watts per kilogram of peak electrical power when cycled up to 30 hertz, as well as up to 41.2 joules per kilogram of electrical energy per mechanical cycle, normalized to harvester yarn weight. We have demonstrated using these harvesters in the ocean to harvest wave energy, sewing harvester yarns into textiles for use as self-powered respiration sensors, and using a single 19.6 mg yarn to power a light-emitting diode and to charge a storage capacitor.

Biography

Carter S Haines is an Associate Research Professor at the University of Texas at Dallas' Alan G. MacDiarmid Nanotech Institute. His research focuses on using carbon nanomaterials and polymer yarns to develop new types of energy harvesters, energy storage materials, and artificial muscles. Applications for these multi-functional fibers include smart yarns and textiles that store and generate energy, and that actuate to respond to their environment.

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