Untapped Static: A New Paradigm for Energy Harvesting Integrating a Cost-Effective Electrostatic-based Generator with Supercapacitors to Optimize Energy Storage and Energy Harvesting Efficiency

Chhabra, Eshan (School: Plano Senior High School)

The world population has steadily increased, as has the demand for energy. To combat this increasing need for energy, energy harvesting research aims for cost reduction and efficiency. However, current mechanical energy harvesting (wind power, hydropower) utilizes Electromagnetic Generators (EMG), which restrict the world from reaching those goals. EMGs are expensive and inefficient. As a result, this project demonstrates a new method of harvesting mechanical energy using electrostatic induction-driven generators. Electrostatic Induction is a cheap and efficient process; Utilizing the triboelectric effect is viable as an alternative to EMGs. Triboelectric Nanogenerators (TENGs), are solid state transducers that work as energy harvesters. A PET film based TENG with 3D spring structure origami configuration, inductively coupled plasma reactive-ion etched dielectric material based TENG, Carbon Nanotube TENG, as well as an organic (circular) shaped TENG. To further increase efficiency, further surface area improvements were made. A new type of electrospun polymer:porogen ratio was used to create an ultra-high surface area dielectric film. To expand on the TENG's applicability, the TENG was integrated with an energy storage device: the supercapacitor. This project aims to explore the overall voltage, current and overall power output with respect to the external load (resistance) of the circuit, speed, and force of the physical contact of the dielectric films of a variety of innovative designs for the TENG-Super capacitor integrated circuit. The goal of this project is to demonstrate efficient energy harvesting and energy storage using new generation methods, at a low cost.

Awards Won:

National Security Agency Research Directorate : First Place Award "Material Science" $1,000