Generating Energy From Wheel Motion by Designing a Hybrid 3D-Printed Triboelectric Nanogenerator

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The drastic increase in fossil fuel consumption and greenhouse gas emissions by conventional vehicles calls for a greener and environmentally friendly alternative, most notably electric vehicles (EVs). However, a significant problem in these vehicles is the energy storage and consumption efficiency. The driving range of an EV on full charge is limited, so the car must constantly be recharged, which is both costly and time-consuming. This project aims at developing a system that can harvest energy as the wheels are in motion to power the batteries and other electrical components. To achieve this, the principles of the triboelectric effect and electrostatic induction are employed by integrating triboelectric nanogenerators (using PDMS as the electronegative material and aluminum as the electropositive), or TENGs, into a hybrid 3D-printed wheel design. The 3D printing technique is used to customize the flexible design of the wheel-TENG to maximize the harvested power output. An electric vehicle prototype utilizing two wheel-TENGs (70mm diameter and 20mm width) in parallel is constructed and shown to generate a peak-to-peak voltage of 10 Volts at a speed of 3 meters/second. To further expand the project, experiments analyzing the effects of wheel speed, surface area, and force applied on the device output are conducted and found to be positively correlated for each. Furthermore, the real-world application of the system is demonstrated by powering the headlights (15 LEDs) of the prototype. These findings open up an opportunity to design flexible, complex, and efficient structures that can be integrated into the wheels of EVs.

Awards Won:
Fourth Award of $500
King Abdulaziz &amp
his Companions Foundation for Giftedness and Creativity: Full Scholarship from King Fahd University of Petroleum and Minerals(KFUPM) (and a $400 cash prize)
King Abdulaziz &amp
his Companions Foundation for Giftedness and Creativity: NOT TO BE READ -- $400 cash prize for each Full Scholarship from King Fahd University award recipient
Patent and Trademark Office Society: Second Award of $500