Improving Energy Efficiency of Electric Vehicles via Piezoelectric Incorporated Materials

Galasso, Damian (School: Galasso Homeschool)

In electric vehicles, about 72% of the power that the battery provides to the wheels is dissipated. Of this, 25% is lost from rolling resistance and 39% is lost from wind resistance. Piezoelectric elements are crystalline materials that produce a voltage in response to mechanical stress. Thus, integrating these elements in tires and outer surfaces of an automobile can improve its overall efficiency. This study focuses on an electromagnetic induction (EMI) and piezoelectric based material to return energy lost from rolling friction and wind resistance, in order to improve the energy efficiency of electric vehicles. A unique piezoelectric/EMI based circuit was integrated into rubber resins to recover energy lost from the tire and outer surfaces of a vehicle. A circuit incorporating several known and novel piezoelectric elements proved most efficient in terms of power output (mW). A single circuit of this of this design returned .2145% of energy dissipated from rolling friction and .0026% of energy dissipated from wind resistance. Additionally, the design was proved scalable: power outputs from multiple circuits increased in a positive square root function curve. Simulated scaling of the piezoelectric/EMI incorporated circuits to 300 rings per wheel and 1,900 modules on the vehicle's outer surfaces led to 138.59% greater range of the vehicle. The superior performance of this novel circuit design can be used to provide highly efficient energy harvesting tires and outer coatings in electric and hybrid vehicles. Additionally, the superior performance, indicated by the coupled electromagnetic induction and piezo elements, can easily be integrated in many creative engineering concepts, such as energy harvesting roads, shoes, and sidewalks.

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