Development of solar supercapacitor by utilizing organic polymer and metal oxides for subsystem of EV

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Abstract
The limitations of the electric vehicles are weight, size, range, charging time and high price tag. Thus, development of a renewable energy-boosting system for EVs is significant. This paper proposes the materials and control system for development of the automotive body panels which are capable to generate electrical energy from solar energy and store the energy not only as structural capacitor but also as solar panel. A solar supercapacitor prototype is developed by utilizing Carbon Fiber Reinforced Polymer, nano Zinc Oxide and Copper Oxide fillers as the positive and negative electrodes and a dielectric layer sandwiched between the electrodes. Different weight percentage compositions of nano CuO/ZnO filled epoxy reinforced Carbon Fiber and different combinations of separators are investigated experimentally. Samples with higher nanoparticle composition can boost both the energy generation and storage performance. Simulation study is conducted on solar supercapacitor concept which is hybrid energy storage system, modelled as the supplementary renewable energy source of electric vehicle. Experiment data from the laboratory scale organic solar supercapacitor are considered as input reference data to design solar supercapacitor HESS in Simulink to generate electricity from solar energy and provide storage. The solar supercapacitor can be considered as the roof panel of EV and simulated at different solar irradiance (200 similar to 1000 W m(-2)) and different load conditions (200 similar to 500 W) to reflect the practical conditions. The test results of SSC show potential of energy conversion efficiency (eta (ec)) 17.78%, open-circuit voltage (V-oc) 0.79 mV, current density (J(sc)) 222.22 A m(-2), capacitance (C) 11.17 mu F cm(-2), energy density (E-d) 120 Wh kg(-1) and power density (P-d) 29 kW kg(-1). Based on Simulink results, fully charged solar supercapacitor system with solar irradiance of 1000 W m(-2) can provide power of 2.3 kWh (18.24 km extra range every hour). Therefore, the system can provide extra 4.56% of conventional EV's power and range per hour. Solar supercapacitor system integrated with EV battery has the potential to reduce battery size by 10%, weight 7.5%.

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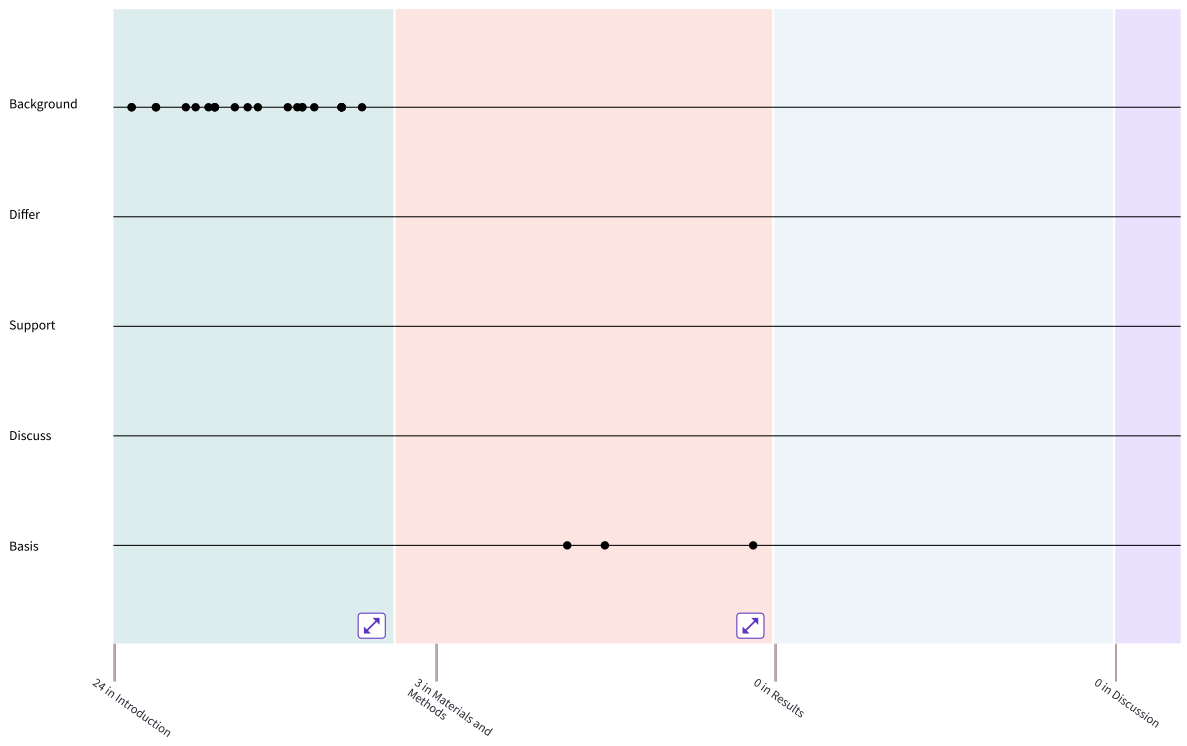

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