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Green Solar Electric Vehicle Changing the Future Lifestyle of Human

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Abstract

Electric vehicle with more advantages of no noise, no pollution, saving energy and reduce carbon dioxide emissions is to power-driven vehicle with a motor drive wheels moving. Solar electric vehicle can make to reduce our greenhouse gas emissions and other pollution. All advantages of solar electric vehicle make research and application of solar electric vehicle as a “hot spot” of automotive industry and the trend of future cars. Solar electric vehicle is made of PV panels, battery, electric motor, vehicle controller and vehicle body. Solar electric vehicle drives using dual-mode of PV and battery hybrid. It can be achieved PV-driven and battery-driven independently. In good sunny conditions, the full charge endurance of solar electric vehicle can be increased about 35% substantially compared with no PV panels. Solar electric vehicle can achieve low-carbon, energy saving, environmental protection and true zero-emissions for the future of human life.

Keywords: *electric vehicle, solar cell, PV, zero emissions*

1 Introduction

In recent years, greenhouse gas emissions and exhaustion of natural fossil resources have become serious global issue [1]. Energy supply security and global warming continue to challenge all countries around the world in terms of global economy and planet environment. Renewable energy technologies are being explored to meet the challenges of energy security and climate change, as well as to boost regional economic development.

Transport is one of the largest sources of human-induced greenhouse gas emissions and fossil-fuels consumption [2,3]. Air pollutants from an automobile contribute to not only regional environmental problems such as human-health effects but global environmental issues like climate change due to CO_2 emissions [3,4]. Thus, the ideal future transport should be directed towards to the use of the zero-emission, no pollution, electric vehicle and/or fuel-cell vehicle, which uses alternative fuel [5]. With ever increasing concerns over environmental protection, carbon emission, energy conservation and energy efficiency in recent years, research and development on various new energy electric vehicle (EV) technologies is being actively conducted [6,7]. Electricity has been explored as an alternative power source to replace or complement the internal combustion engine for decades.

Nowadays, developed countries and big cities throughout the world are embarking on policies to encourage the research and use of EVs [8,9]. China also has introduced several policies to encourage the use and promotion of new energy vehicles. China's large cities have air pollution can not be ignored. Automobile exhaust emissions are one of the major sources of pollution. China has 10 cities were included in the global atmospheric pollution in the world's most serious among the 20 cities. However, global fossil fuels will be exhausted by the middle or end of 21st century and we will have to look to another major source of clean and renewable energy to support the request of human being [10]. Research and development of electric vehicles in China is not a temporary short-term measure, but a significant and long-term strategic consideration.

In the paper the newest research and development results of solar electric vehicle (SEV) are reported for the first time. SEV is made of PV panels, battery, electric motor, vehicle controller and vehicle body. SEV is driven using dual-mode of PV and battery hybrid. It can be achieved PV-driven and battery driven independently. In good sunny conditions, SEV doesn't need an industrial power charging for several days. SEV can achieve low-carbon, energy saving, environmental protection and true zero-emissions for the future of human life.

2 Solar cell and module

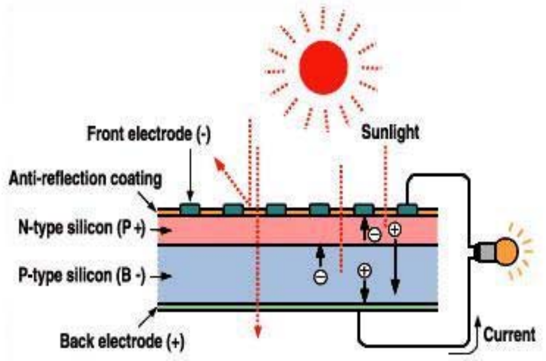

Figure 1: typical schematic diagram of the solar cell

A solar cell is an electronic device which can use photovoltaic (PV) effect to directly convert sunlight into electricity. Light shining the solar cell will produce both a voltage and a current to generate electric power[11]. A typical schematic diagram of silicon solar cell is shown in Fig. 1. PV energy conversion in solar cells consists of two essential steps. First, a material in which the absorption of light generates an electron-hole pair is required. The electron and hole are then separated by the structure of the device electrons to the negative electrode and holes to the positive electrode thus generating electrical power.

A variety of materials and processes can satisfy the requirements for PV energy conversion, but in practice nearly all photovoltaic energy conversion uses semiconductor materials in the form of a p-n junction[12]. Conventionally, solar photovoltaic materials use inorganic semiconductor materials. Semiconductors of interest allow the formation of charge-carrier separating junctions. The junction can be either a homojunction or a heterojunction with other materials to collect the excess carriers when exposed to light.

In principle, a large number of semiconductor materials are eligible, but only a few of them are of sufficient interest. Ideally, the absorber material of an efficient solar cell should be a semiconductor with a bandgap of 1~1.5 eV, a high optical absorption (10^4-10^5 cm^{-1}) in the wavelength region of 350-1000 nm, a high quantum yield for the excited carriers, a long diffusion length low recombination velocity. If all these constraints are satisfied and the basic material is widely available, the material allows in principle the manufacturing of a solar cell device.

Based on structure of solar cell, solar cells can be divided into crystalline silicon solar cells and thin film solar cells. Crystalline silicon solar cell can be made into only in panel. However, thin film solar cell can be made into not only panel but also in flexible roll to roll.

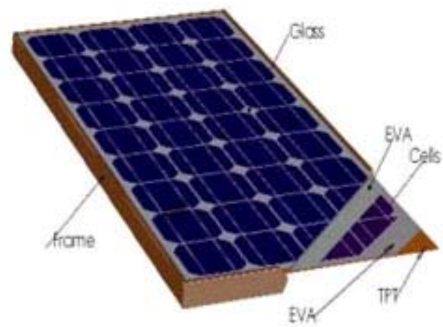

Figure 2: typical schematic diagram of the solar module

PV modules consist of a number of interconnected solar cells encapsulated into a single, long-lasting and stable unit. The key purpose of encapsulating a set of electrically connected solar cell is to protect them and their inter-connecting wires from the typically harsh environment in which they are used. The two key functions of encapsulation are to prevent mechanical damage to the solar cells and to prevent water or water vapor from corroding the electrical contacts. Module lifetimes and warranties are often about 25 years, indicating the robustness of an encapsulated PV module. It is a five layer structure for the silicon PV module. Most of silicon PV modules consist of a transparent top surface, an encapsulant, a rear layer and a frame around the outer edge. In most modules, the top surface is a low iron tempered glass, the encapsulant is EVA and the rear layer is Tedlar (TPT), as shown in Fig. 2.

3 Electric vehicle

Good features of EVs are clean and easy to handle not only in driving but also in the development. There are three types of electrically powered vehicle, including hybrid electric vehicle (HEV), plug-in hybrids electric vehicle (PHEV) and pure electric vehicle (PEV). A HEV is designed to use both an electric motor and an internal combustion engine. A conventional HEV is a vehicle in which propulsion energy is available from two or more kinds or types of energy stores, sources or converters, and at least one of them can deliver electrical energy. A PHEV is very similar to the conventional hybrid electric vehicles available in the market today and use a combination of grid electricity, regenerative energy from braking, and power from another onboard source, such as an internal combustion engine or fuel cell. High battery performance is the key technology for the application of PHEV. A PEV uses batteries to power the motor engine instead of petrol. It is significant that there no greenhouse gas emissions. PEVs rely only on batteries which are recharged from the grid or by regenerative braking.

4 Solar electric vehicle

On the basis of the PEV, SEV and solar electric bus (SEB) are developed in our company. The research on SEV and SEB has been developed for a long time. SEV and SEB can achieve low-carbon, energy saving, green, environmental protection and true zero-emissions for the future of human life. SEV uses dual mode of battery and solar to be driven. It can be achieved PV-driven and battery-driven independently. SEV is made of PV panels, battery, electric motor, vehicle controller and vehicle body. PV panels are installed on the top of vehicle or on the sides of the vehicle body. PV panels and vehicle batteries are connected through the vehicle controller. PV panels can not only directly charge the batteries, but also directly supply power to the motor. The important role of the vehicle controller is to manage the operation of vehicle and the distribution of electricity shown in Fig. 3.

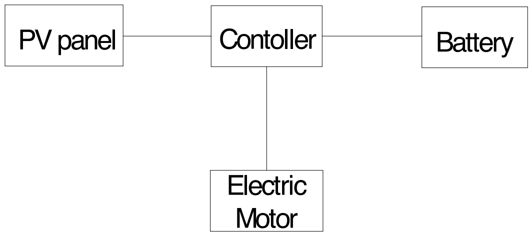

Figure 3: schematic diagram of controlling mode

4.1 Example for solar electric vehicle

We present an example of the application of SEV Kundi shown in Figure 4. SEV Kundi which is a modified car from the Noble's vehicle body of Shuanghuan Auto is a new energy car with the advantages of beautiful, fashion and personality. SEV Kundi adds some elements of micro-car based on coupe, which makes it easy to include the advantages of three types of vehicles: convenience and comfort, cool and innervations of a sport car, flexible and energy-saving of mini-car.

Figure 4: a photo of Kundi with flexible solar cells

The appropriate battery configuration is one of the most important subjects to develop EV. It depends on the size and weight of the original car, the weight of batteries, and performances of electric motor. SEV Kundi is designed using a driven electric motor of 7.5 kW for a voltage of DC 72 V. However, the batteries providing 9.36 kWh power under the assumption require one battery pack has 130 Ah capacities. Normally, an EV can travel 10 to 15 km/kWh; it is obvious that the energy is not enough for a car in normal use. Flexible thin film solar cells are installed in the roof and front flip. In sunny conditions, solar cells convert sunlight into electricity continuously and the electricity is stored in batteries by the controller. The full charge endurance of SEV Kundi can increase 35% substantially compared with no PV module.

4.2 I-V curves of PV module

The I-V measurement results of PV modules of the SEV are presented in Figure 5. The standard condition to evaluate the efficiency of the PV modules, which is currently the standard test condition (STC), i.e., the incident solar irradiance: 1000 W/m^2, the solar spectrum distribution: AM1.5, PV modules test temperature: 25 °C, is essential because environmental conditions greatly influence the output energy value of PV modules[13]. Maximum PV conversion efficiency of 14.27% is achieved from the PV modules. Open-circuit voltage (Voc), short-circuit current (Isc), maximum power (Pmax) and fill factor (FF) are 44.9 V, 5.44 A, 182 W and 0.7446, respectively.

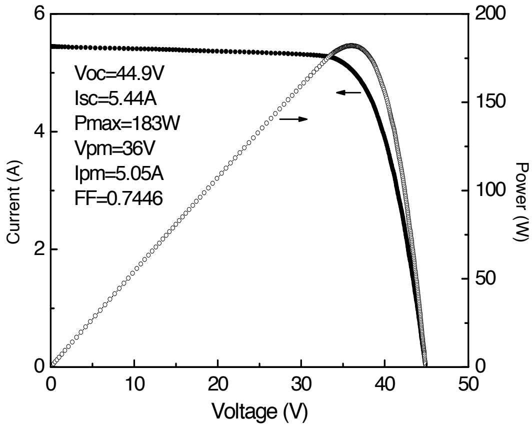

Figure 5: I-V characteristics curves of PV module

4.3 Road performance test

In order to get performance parameters of SEV, the real vehicle test on road for SVE is developed in the conditions of with PV modules and without PV modules. In good sunny day the road experiments are tested continuously about 6 to 8 hours every day. The speed of SEV is controlled in the range of 20 to 40 km/h. Comparison of the driving range for SEV with PV modules and no PV modules is shown in Figure 6. SEV Kundi without PV modules could travel 98-103 km distance for one charge where approximately 8 kWh electric powers had been consumed. However, SEV Kundi with PV modules could travel 132-138 km distance for one charge. It is obvious that SEV Kundi with PV modules can increase driving range of 35 km. In good sunny day PV modules can generate electric power about 2.5 kWh. With increase of efficiency of solar cells, more and more electricity power can be generated by solar cells in the same size.

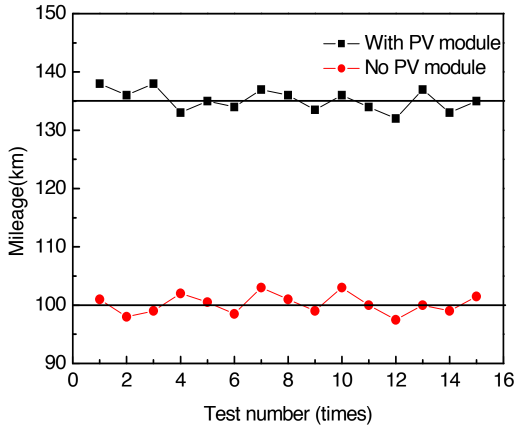

Figure 6: comparison of the driving range for SEV with and no PV module

5 Conclusion

In the paper, SEV project has been reported in which a SEV Kundi was developed by converting sunshine into electricity to realize green and clean transportation. SEV Kundi is driven using dual-mode of PV and battery hybrid. It can be achieved PV-driven and battery-driven independently. SEV Kundi has been tested to drive on roads and achieved an average distance of 135 km traveling by one charge in good funny days. The efficiency is about 15 km/kWh while it is varied depending on road conditions and weather conditions. A perfect SEV can achieve low-carbon, energy saving, environmental protection and true zero-emissions for the future of human life.

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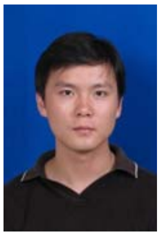

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