полученных с помощью компьютерной программы Origin, в которой была проведена аппроксимация, учитывая геометрические размеры пленки, можно получить значение ширины W и высоты V_0 туннельного барьера для каждого из исследуемого образца.

На основе температурной зависимости сопротивления установлено, что на большом интервале температур основной вклад в сопротивления пленок из углеродных нанотрубок может быть объяснен в рамках модели флуктуационно-индуцированного туннелирования. Однако при очень низких температурах необходимо учитывать вклад и других механизмом электропроводимости.

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Using solar panels to recharge car battery

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Today, solar energy technologies for automobiles perform mainly auxiliary functions: battery recharging, power supply in the field, and others. A solar cell in a vehicle can compensate for battery self-discharge and leakage current during long periods of parking. An example of using solar cells to recharge electric vehicles (electric scooters, electric cars) is a charging station.

Currently, there are several applications of solar panels in automobiles: 1) solar cars, which use the energy of the sun to move, 2) recharging the battery, 3) powering additional devices while driving and parking, 4) solar-powered stations for recharging electric cars.

The first solar car model was developed by William Koob in 1955. The first production solar car VenturiAstrolab was released in 2006. It was equipped with a 16 kW asynchronous electric motor with 50 N·m of torque, a 7 kWh nickel-metal-hybrid battery, and a 600 W panel solar panel.

The designs and characteristics of solar cars are constantly improving: increasing the power and area of solar cells, developing effective systems of electric drive, reducing the coefficient of aerodynamic drag to 0,10–0,12. For twenty years, the average speed of solar-powered electric cars has increased more than fourfold.

The principle of solar cells is to produce direct current when sunlight strikes monocrystalline/polycrystalline silicon wafers. The total power of solar cells depends on the total number of silicon wafers used and the surface area of the wafers. Typically, it is 0,74 kW for a total solar panel area of 2 square meters. The performance of solar panels is directly dependent on the intensity of solar radiation and the angle of placement of the solar modules. The amount of solar energy entering the territory of Russia in a week exceeds the energy of all Russian reserves of oil, gas, coal and uranium [1, 2].

Currently, there is a large variety of solar cell battery designs, including flexible film-based, which allows them to be placed on a curved surface. Placement of solar panels on vehicles can be: horizontal (the most common type of arrangement); vertical (encountered much less often than horizontal); with adjustable tilt and turn (tracking system); integrated (on the entire outer surface of the vehicle); remote (eg, on a car trailer); inside (under the glass) and outside the vehicle (on the roof).

Today there are several models of solar-powered devices for charging the vehicle's discharged battery. For example, the device of firm "Velleman" thanks to energy of the sun allows to receive pressure on an output not less than 13,5 V at a current strength in 350 mA that on assurance of developers, quite enough for start of the car with absolutely discharged accumulator [3]. In the manual of the device it is indicated that it is designed to charge the battery on clear days or days with little cloudiness. In fact, in sunny weather with low clouds and air temperature outside the car, about 18–20 °C, the charging current was about 180 mA. But even this current is enough to start the engine of the car with a discharged battery.

The solar battery in the car can compensate for the self-discharge of the battery, and the leakage current during long periods of parking. When the car is not in use, the power balance is negative during parking: the cabin light comes on when you leave the car, the door lock solenoids work, the alarm, the on-board computer and the clock consume about 12−15 mA. The battery should not be discharged for a long time: sulphation, loss of capacity, irreversible processes develop, recovery methods are not always efficient and often not long-term. To compensate losses it is necessary to obtain from solar cells a voltage of not less than 13,5−14,5 V and a current of 60−150 mA, charging with a small current (equalizing charge) positively affects the battery, prolonging its life. If the voltage is higher, electrolysis will occur, the electrolyte level will drop, hydrogen will be released, and the acidity of the electrolyte will change. If the voltage is much lower, the battery will not charge at all. Therefore, in the electrical circuit with a powerful solar battery, capable of recharging the battery, it is necessary to connect a controller [4].

The simplest controllers simply disconnect the solar panel when the battery voltage reaches about 14,4 V (for a battery with a nominal voltage of 12 V). When the battery voltage drops to 12,5−13V, the solar battery is reconnected and charging is resumed. The maximum battery charge level is 60−70 %. More advanced controllers at the final stage of the charge use so-called pulse width modulation (PWM − power wide modulation) of the charging current. In this case it is possible to charge the battery up to 100 % [5].

Solar battery of small size with power less than 10 watts has a significant internal resistance and will be a source of current, as it is loaded on the battery with low internal resistance. As much as it has worked out, so much has given back to the battery. Therefore, it is inexpedient to put a controller, as it is a consumer itself (from 5 mA and more depending on the model, around the clock), and when the engine is running the battery is perceived as fully charged, and turns off the solar battery. Discharge can be avoided by including a Schottky diode in series with the solar cell.

Solar cells are indispensable for a car that is in the field for a long time (expeditions, exercises, hiking, etc.), where the battery has a heavy load: running stereo, car refrigerator, laptop, turned on headlights, etc.

The main element of uninterruptible and autonomous power supply is a power inverter (Fig. 1).

It converts the energy stored in the battery into standard 220 V voltage, providing the necessary power and starting currents. The battery may not be discharged more than 50 % as otherwise the inverter will shut down. Charging 36 A/h at maximum power of ten watt solar panel will take 45 hours, when reducing the power the time increases accordingly.

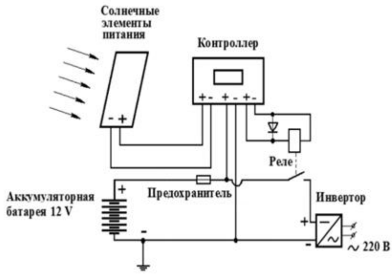

Fig. 1. General scheme of connection of solar cells
for recharging the battery and autonomous power supply

An example of using solar cells to recharge electric vehicles (electric scooters, electric cars) is a charging station consisting of three main components:

− a moving panel (solar panel). Electricity in the system is generated by a biaxial photovoltaic generator with 12 modules. The solar panels move behind the sun. Therefore, such a system generates 40 percent more energy than similar static systems;

− an energy storage system. Vanadium redox batteries are used to store energy. The batteries can accumulate up to 100 kWh of energy, providing up to 10 kW of current, which in turn makes it possible to get the energy you need at any time;

− intelligent electric recharging system (connection). It can determine the make and the owner of the car being charged at the moment, keep financial and quantitative records of the recharged energy [6].

Fig. 1 shows a general connection diagram of solar cells for recharging the battery and autonomous power supply.

Thus, today, the technology of solar energy application for road transport performs mainly auxiliary functions: battery recharging, power supply in the field and others [7−8].

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Функциональная диагностика системы управления асинхронным тяговым приводом электровоза

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Функциональный контроль и диагностирование электровозов представляет собой актуальное направление исследования, находящегося на стыке технической диагностики и современной теории управления. Система управления электровозов переменного тока является сложным динамическим объектом, имеющим различное взаимосвязи между управляемым электрооборудованием, предназначенным для регулирования его режима работы, то есть перехода от одной установившейся скорости к другой, сопровождаемой изменяющимся тяговым моментом.

С точки зрения технической диагностики различные режимы электровоза требуют правильности их функционирования в данный момент реального времени, то есть оперативности получения информации о перехо-