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TECHNOLOGY FOR PREPARING SAMPLES FOR STUDYING ELECTROPHYSICAL AND OPTICAL PROPERTIES OF DOPED AND UNDOPED BAMBOO STALMS

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Abstract. *The fundamental parameters of natural semiconductor fibers, the dependence of electrical conductivity on temperature, and the photoconductivity of doped semiconductor bamboo fibers have been studied. The temperature dependences of the current-voltage characteristics and the electrical conductivity of bamboo doped and undoped with iodine were studied to create new elements of electronic equipment.*

Key words: *Bamboo doped with iodine, photoconductivity, electrical conductivity spectrum, temperature.*

Introduction

Today, the demand for new semiconductor compounds and materials is growing in the world. At the same time, the great demand for natural semiconductor materials particularly requires extensive research into the physical processes of such natural semiconductors, such as bamboo fibers. One of the most important tasks in this direction is to carry out the following targeted scientific research: determining the fundamental parameters of natural semiconductor fibers; demonstrate the laws of the dependence of electrical conductivity on temperature; determination of photoconductivity spectra of undoped and doped semiconductor bamboo fibers; creation of new elements of electronic equipment based on them. A broad study of the mechanisms of physical processes occurring in various natural semiconductor fibers is one of the urgent scientific tasks in this direction [1].

As you know, bamboo fibers are a naturally environmentally friendly material with antibacterial and deodorizing properties. It absorbs moisture perfectly. Fabrics made from bamboo fibers retain their shape without allowing external mechanical influence - deformation [2].

Experiment

The samples for the experiment were natural bamboo stems, which were prepared using the technology described in [3]. For the process of alloying with iodine, bamboo stems were first cut into small pieces using a hacksaw, successively processed in distilled water and placed in a glass tube with a diameter of D = 1÷5 mm, then the cut side was immersed in a 5% alcohol iodine solution.

After soaking, the samples were kept at a temperature of 60÷80 ^{0}C for 15÷300 minutes, then dried in a chamber for 5 hours in the presence of moisture-absorbing silica gel. To obtain ohmic contacts, we used prepared electrically conductive adhesive based on a mixture of graphite and liquid glass [4], where crushed graphite, like powder particles, is mixed with liquid glass until thickened. Such electrically conductive adhesive has a resistance $R = 3 \cdot 10^2$ O, films with l = length 1 cm and thickness d = 20 microns. As a result of electrical measurements, it was established that the current-voltage characteristics (volt-ampere characteristics) of the samples correspond to a linear dependence [5].

Fig. 1. Prepared samples for research

To obtain ohmic contacts, bamboo fibers were placed parallel to each other and cut to the same length using a cutter [6]. Electrically conductive glue is applied to the ends of the cut fibers, samples with the required dimensions, which are located in parallel, and placed in a drying chamber (Fig. 1).

Experiment results

The current-voltage characteristic of bamboo fibers was measured using a simple method at a temperature T = 300K. To obtain high-quality results, the F195 micro-nanoammeter is used, which is capable of measuring very small current pulses in nanoamperes (Fig. 2).

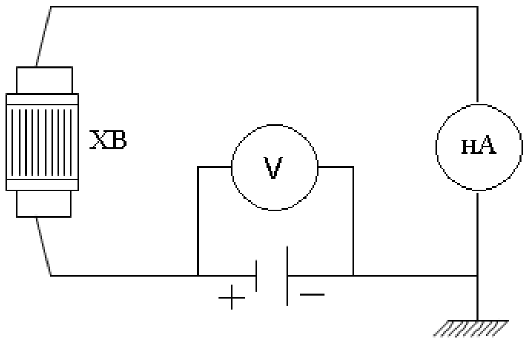

Fig. 2. Schematic design for measuring the current-voltage characteristics of bamboo fibers.

Typically, the electrical conductivity of semiconductor materials varies exponentially with temperature. Bamboo fibers have similar physical properties.

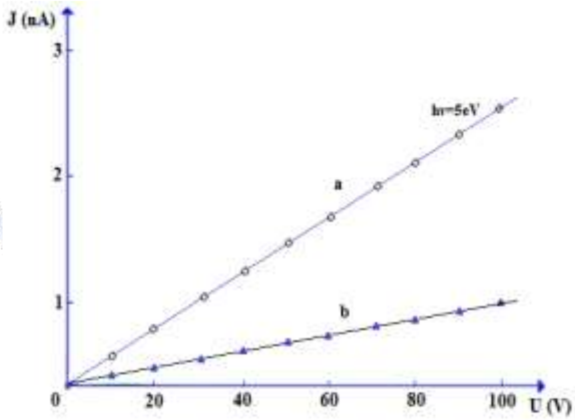

Fig 3. Current-voltage characteristic of an undoped bamboo stem treated at a temperature of 30 ^{0}C. a) CVC under illumination of 5 eV (hv = 5 eV). b) CVC in the dark (hv =0eV).

The prepared bamboo stem was exposed to voltages from 0 to 100 V at different temperatures and the current-voltage characteristic was studied. It was observed that the leakage current value of the undoped bamboo stem sample increases at higher temperatures (Fig. 3).

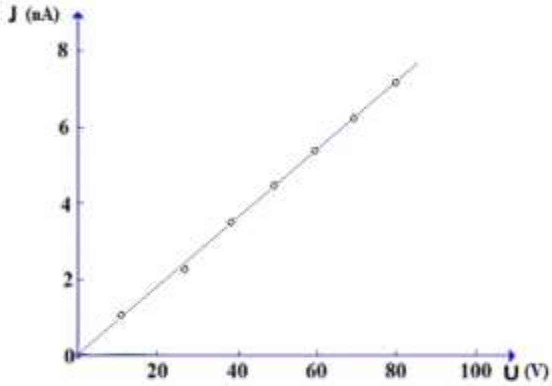

Fig. 4. Current-voltage characteristic of a bamboo stem doped with iodine. At a temperature of 75 ^{0}C (Processing 4.5 hours)

As can be seen from Figure 4, the electrical conductivity of a bamboo stem ($\sim\sigma$) increases exponentially with activation energy in the temperature range 0÷100 ^{0}C. As a result of research, it was revealed that the amount of current passing through a bamboo stem increases exponentially depending on the external temperature.

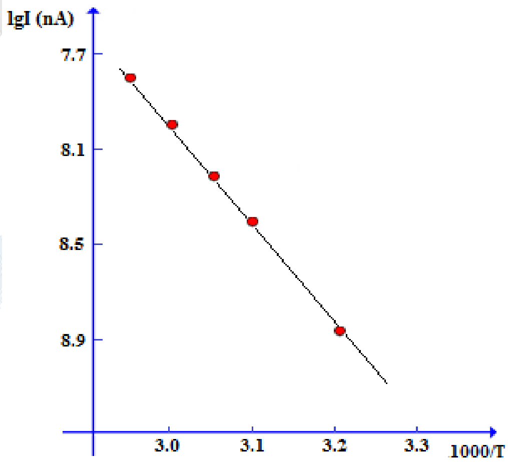

Fig. 5. Activation energy of an undoped bamboo stem at a voltage of U=800V.

As a result of the study of samples made from bamboo stems and processed at temperatures of 60 ^{0}C, 65 ^{0}C, it was established that the activation energy value when processed at different temperatures and under a constant voltage load is different. The samples were processed at a temperature of 60 ^{0}C for 2 hours and tested at voltages of 20 V and 100 V. As a result of the tests, it was found that the activation energy of the sample was 0.82 eV for undoped bamboo (Fig. 4), and 0.57 eV for bamboo doped with iodine (Fig. 5).

Conclusion

Based on the experimental results obtained, it was established that, based on the temperature dependence of the electrical conductivity of samples doped and undoped with iodine, bamboo stems, electrical conductivity increases in a direct relationship with increasing temperature, and the thermal ionization energy is E_t=0.57 eV. The temperature dependence of B AX and electrical conductivity of a bamboo stem was studied.

It was revealed that the magnitude of the passing current in bamboo stems doped with iodine and manganese significantly exceeds the current magnitude of the undoped bamboo sample.

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