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STUDY OF THE PHYSICAL PROPERTIES OF TYPHA A SEMICONDUCTIVE NATURAL FIBER PLANT

Annotation. It was revealed that the photoconductivity spectra of various grades of natural fibers typha doped with iodine are quite different. It was found that the electrical conductivity of typha fibers undipped and doped with iodine and $KMnO_4$ increases exponentially with increasing temperature. Infrared quenching and long-time relaxation of the photoconductivity of cotton fibers doped with iodine were detected. For the first time, it was found that with small doses of UV irradiation of silkworm green, the quality of silk fibers improves, and with large doses it worsens.

Keywords. Natural plants, typha and silk fibers, alloying, photoconductivity, electrical conductivity.

I. INTRODUCTION

Recently, research has been successfully conducted in the field of physics of natural fibers. This, in particular, is due to the fact that semiconductor properties are detected in typha and silk fibers (TF and SF). Natural polymers such as typha and silk fibers have structures of successively alternating crystalline and amorphous regions. The electrophysical and optical properties of TF and SF are very sensitive to external influences (temperature, alloying, uniaxial pressure, humidity, light) and can easily be modified to obtain materials with desired properties. Based on typha fibers, thermistors, photosensitive materials, humidity sensors, photodiodes and field effect transistors were created. When treating the surface of TF, it was revealed that the properties are mainly determined by grade and cuticle of the surface part of TF with a thickness of the order of 1 μm with a conditional fiber diameter of 12-14 μm. Photoluminescence and photoconductivity (PC) in the intrinsic absorption region of TFs doped with iodine were also found in TF. Also, the infrared quenching and the long-time relaxation of photoconductivity are due to the adherence of charge carriers to the deep levels formed upon the introduction of iodine into an TF were found.

This paper presents the new research results of TF and SF.

For this study, the samples were prepared using the following technology. The object of the study was cotton and silk fibers. In order to dope TF with iodine, first, a seed of TF was thoroughly combed with a fine comb (with a spike period of 0.4 mm), then seeds were cut from the side. Then, TF was soaked in 5 or 10% alcohol solution of iodine. Then iodine diffusion was carried out at T = 60-80^{0}C for 5-8 hours. Further, in order to make ohmic contacts, an electrically conductive adhesive based on graphite and liquid glass was developed. The crushed fine-grained graphite was mixed with liquid glass to a thick state. After that, such an electrically conductive adhesive (R = 300 Om with a thickness of 20 μm and a length of 1 cm) was applied to the end sides of the TF and SF. This made possible to obtain reproducible measurement results. Note that in parallel laid fibers are 2000-7000 pieces. The length of the sample was 5 mm. Electric current and voltage was measured using a DMM 6500 KIETHLEY millimeter. The current-voltage characteristics of the fabricated samples in the forward and reverse directions are linear. Measurements showed that after doping of TF with iodine, the samples had n-type conductivity. Note that the increase in the number of fibers is connected with the limitation of the measurement of small current values by measuring instruments.

Ligature $KMnO_4$ was dissolved in distilled water. We prepared a 2% aqueous solution of $KMnO_4$. This solution was applied to the surface of the TF, after which they were dried for one hour at room temperature, then diffusion was carried out at 50^{0}C for 1 hours.

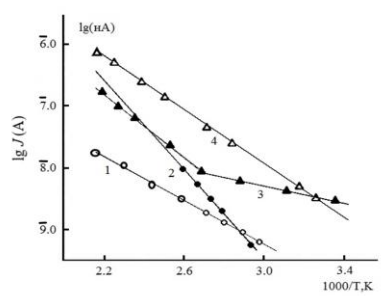
To determine the time of the fracture for natural fibers, samples were prepared as follows. First, a fiber grade was selected. One fiber comes off the seeds (if it is TF) and washed in distilled water at 100 ^{0}C. Then, on both sides of the fiber, it is smeared with liquid glass and glued to paper cardboard with a thickness of 0.5 mm with a hole. Then at room temperature it is kept for 7 hours.

In order to investigate the physical properties of the joint SF, the special cocoon unwinding installation has been created, which allows obtain a single joint SF without breaking up to 1200 m. The layout of the installation for cocoons unwinding is shown in. After unwinding, the welds were washed 3-5 times in distilled water at a temperature of 75^0C. The remaining procedures for the preparation of TF samples are similar to the technology used for TF.

II. EXPERIMENTS AND DISCUSSION

It follows from the experiments that, under the same initial conditions, the spectra of the PC of various TF grades doped with iodine are different from each other. This can be explained by the fact that the upper shell - cuticle of TF depends on their grade which manifest itself in the PC spectra. The PC spectra of various types of CFs doped with iodine are shown in, measured at temperature of T = 300K. PC spectra were measured using an IRM-1 monochromator with a NaCl prism. The slit width was 0.01 mm.

It has been established that the electrical conductivity of the TF of grades undoped and doped with iodine and $KMnO_4$ increases exponentially with a certain thermal ionization energy with increasing temperature. This picture shows the temperature dependences of the electrical conductivity of various TF grades doped with iodine and $KMnO_4$



Temperature dependences of electric current passing through various grades of TF. <$KMnO_4$>

It was established also that, after TFs doping, the ionization energy of deep levels changed, which is apparently connected with the interaction of the structure of TFs with iodine.

The photoconductivity (PC) of various types of TFs doped with iodine was studied. It was revealed that when a sample is illuminated with light energy hν = 5.0 eV, the photocurrent increases exponentially with time. The ratio of the photocurrent to the dark current is equal to I_{ph} / I_d = 22-100. This allows make photodetectors operating in the UV region of the spectrum. Under combined lighting, IR quenching of photoconductivity was observed in all varieties of TF. IR quenching of TF is explained by the recharging of deep levels under combined lighting. After illumination of the sample with light of $h\nu \geq E_g$, (E_g is the band gap), long-time relaxation of the PC after turning off the light is revealed. With an increase of the intensity of its own backlight, an increase in PC was detected. This is due to a change in the degree of filling of a deep level of iodine in the forbidden zone of TF.

The dependence of the breaking strength of a single silk fiber on the time of UV (hv = 5.0 eV) irradiation of silkworm green was determined.

III. CONCLUSIONS

A technology has been developed for doping typha and silk fibers with an admixture of iodine and $KMnO_4$. An installation has been created for unwinding cocoons to a single silk fiber without breaking up to 1200 meters. A setup has been created for determining the time of rupture under uniaxial mechanical stress of single natural fibers. It has been established that at the same initial conditions the photoconductivity spectra of different varieties of typha fibers doped with iodine are different from each other. This is due to the interaction of iodine with the surface - cuticles, which have different properties depending on the grades of typha fibers. This can be used to identify varieties of typha fibers. It has been established that the electrical conductivity of unalloyed and doped with iodine and $KMnO_4$ of various types of TF increases with increasing temperature exponentially. It was revealed that upon doping of TFs, the ionization energies of deep levels changed, which is associated with the interaction of the structure of TFs with iodine. IR quenching and long-time PC relaxation after illumination of TF<J> was detected. IR quenching of PC is explained by recharging of deep levels under combined lighting.

For the first time, the dependence of the tensile strength of a single silk fiber on the time of UV irradiation of silkworms was studied. It was revealed that the low doses of radiation improves the quality of silk fibers.

ACKNOWLEDGMENTS

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