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**Research Article**

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# Investigation of Mechanical and Electrophysical Properties of Cattail Fibers

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**Abstract** The physical properties of natural fiber-cattail. Dependences of the change in the mechanical stress of the cattail against deformation are obtained. It is shown that in the case of corn doped with $KMnO_4$ the electrical conductivity increases with increasing temperature according to an exponential law.

**Keywords** cattail, fiber-containing, electrical conductivity, photoconductivity

## Introduction

Natural fibers have a microfibrillar structure with alternating amorphous and crystalline regions, the dimensions of which are on the order of nanometers. Of great interest are natural polymer fibers possessing semiconductor properties [1-3]. They have a high sensitivity to light, temperature, humidity and doping with chemical elements.

In recent years, much attention has been paid to studying the physical properties of fiber-containing plants. For example, the study of the physical properties of cotton fibers and the influence of various external influences on them is devoted to the work [2], where special attention is paid to the study of electrical conductivity of cotton fibers and its connection with structural changes.

From the analysis of the literature, it follows that although the cattail has surprising properties, little studied aspects remain the study of its structure, mechanical and electrophysical properties.

In this paper, the properties of natural fiber - cattail, in the direction of its fiber content, the physical properties and the degree of strength are determined.

To investigate the mechanical properties of the cattail, a special installation was assembled that made it possible to perform a linear stretching under load, and a micrometer (0.01 mm accuracy) installed on this unit allowed to record small changes in elongation.

Further, with the help of the assembled unit, the dependence of the mechanical stress on deformation was studied. The 12 cm long samples undergone a linear stretching under the influence of loads. The graph of the dependence of the mechanical stress on deformation is shown in Fig. 1 (curves 1,2). As can be seen from the graph, the section OA characterizes the elastic deformation and agrees quite well with Hooke's law. On the section AB there is a slow growth of the deformation. Then, an increase in deformation is observed in the BC section with small changes in the mechanical stress, which apparently indicates the appearance of "fluidity".

Experiments were carried out on the test sample during the stepwise removal of the loads (Figure-1, curves -2) and it was found that the specimen of the cattail for a long time did not restore the original length. This fact indicates that in the samples there was a residual deformation (ε0).

The electrophysical properties of the surface layers of the cattail after their treatment with $KMnO_4$ were also studied. It was found that after a step-by-step removal of the mechanical load, residual deformation occurs.

It was established for the first time that the surface layers of fibrous cattail have semiconductor properties. Experiments show that the initial conductivity and doped with KMnO4 fibrous bodily conformation increases

with increasing temperature according to an exponential law with activation energy E1 = 0.33; 0.18 eV and E2 = 0.5 eV, respectively.

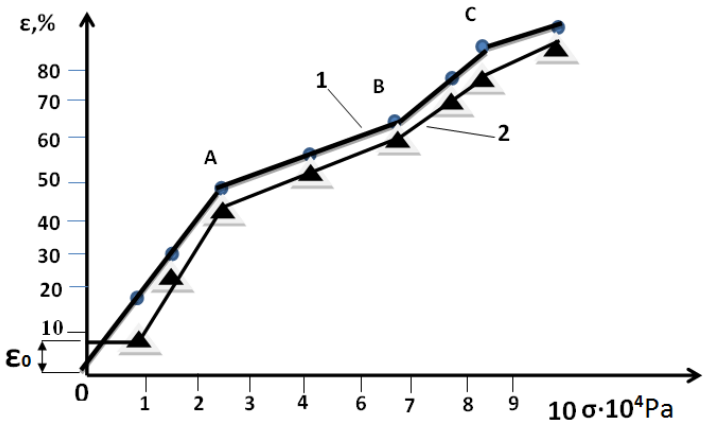


*Figure 1: Elongation of the sample when the load is applied. 1-with increasing load, 2-with load release*

The instability of the electric current is revealed with an increase in temperature from 300 to 340 K. Voltampere characteristics in the dark and when illuminated with UV light with h ν = 5.0 eV are linear. When UV light is turned on, the photocurrent rises according to an exponential law with θ = 5-10 min. After switching off the UV light, a long-term relaxation of the photoconductivity was observed, due to the attachment of charge carriers to deep levels in the forbidden band of the cattail, formed after processing them with KMnO4.

A reduction in the electrical conductivity after doping of fibrous corn-cobs with KMnO4 was observed. This, apparently, is associated with a decrease in free carriers due to compensation by deep levels of fibrous cattail.

Based on the conducted studies, signal-photocell converters with high sensitivity in the visible and ultraviolet regions of the optical spectrum were created. The current-voltage characteristics of the created signal converters in the dark and under illumination are of a linear nature.

The data obtained will help in understanding the physical properties of the cattail and can be used in practical medicine.

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