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## EXPERIMENTS OF WORLD SCIENTISTS ON COTTON CELLULOSE

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## EXPERIMENTS OF WORLD SCIENTISTS ON COTTON CELLULOSE

Cover Page Footnote

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Erratum

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**EXPERIMENTS OF WORLD SCIENTISTS ON COTTON CELLULOSE**

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**Abstract:** *The article provides information on some of the experiments and results of world scientists who have been achieved in the field of cotton cellulose in modern scientific laboratories. The article also briefly describes the first Uzbek scientists and founders who conducted research in the field of cotton cellulose.*

**Key words:** *cellulose, cotton, polymer history, biopolymer, polymer, composite material, nanostructure, nano particle.*

**ДУНЁ ОЛИМЛАРИНИНГ ПАХТА ЦЕЛЛЮЛОЗАСИ БИЛАН ОЛИБ БОРГАН  
ТАЖРИБАЛАРИ**

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Халқ таълими вазирлиги хузуридаги Халқ таълими маркази

Техника фанлари доктори, профессор

**Аннотация:** *Мақолада ҳозирги кун илмий лабораторияларида дунё олимларининг пахта целлюлозаси билан олиб бораётган айрим тажрибалари ва эришган янги натижалари ҳақида маълумот бериб ўтилган. Шунингдек, мазкур мақолада целлюлозанинг илк асосчилари, пахта целлюлозаси соҳасида илмий тадқиқотлар олиб борган ўзбек олимлари ҳақида қисқача тўхталиб ўтилган.*

**Калит сўзлар:** *целлюлоза, пахта, целлюлоза тарихи, биополимер, полимер, композицион материал, наноструктура, наноқисм.*

**ЭКСПЕРИМЕНТЫ МИРОВЫХ УЧЕНЫХ ПО ХЛОПКОВОЙ ЦЕЛЛЮЛОЗЕ**

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**Аннотация:** *В статье представлена информация о некоторых опытах и результатах мировых ученых, которые достигнуты в области хлопковой целлюлозы в современных научных лабораториях. В статье также вкратце написано о первых*

узбекских ученых и основателей, которые проводили исследования в области хлопковой целлюлозы.

**Ключевые слова:** целлюлоза, хлопка, история полимера, биополимер, полимер, композиционный материал, наноструктура, нано частица.

Cellulose - the most common natural polymer on earth - is a very important object of research, since its field of use expands every year, and the available reserves with rational use may be inexhaustible.

Currently, cellulosic materials are actively used to create a variety of nanostructures: nanocrystals, nanofibers and nanocomposites. Nanocomposites can be completely formed from cellulose (with the matrix being longer fibers, and the filler is cellulose nanocrystals), may contain metal nanoparticles of semiconductors, have an organic matrix of bacterial or chemically modified cellulose. In composite materials, cellulose is also combined with synthetic polymers. [1]

### **The first founders of pulp**

For the first time, the terms cellulose and lignin were introduced into science by the French chemist Ansel Payen. He published his article on this in 1838, and in 1839 the term cellulose appeared in the literature. A. Payen discovered the chemical composition of the stages of plant growth. According to the source, the cellulose content is carbon-43.85%, hydrogen-5.86% and oxygen-50.28%. After the invention of A. Payen, research on the processing of cellulose became active.

Alexandr Pavlovich Zakoshchikov - a famous chemist who conducted research in the field of cellulose from 1920 to 1980. A.P. Zakoshchikov comes from Russia to Tashkent and since 1929 has been studying the structure, chemical composition, ripeness and other properties of cotton fiber. Also, he determines that well-ripened cotton contains 97-98% pure cellulose.

Until today, scientists from our republic have conducted many experiments related to cotton cellulose, and several scientific discoveries have been made in this field. In Uzbekistan, cotton cellulose was first studied by Academician Kh.U. Usmonova (1916-1994). Nowadays, students of Academician Kh.U. Usmonov continue to study cotton cellulose. Of them: Academician G. Rakhmonberdiev works on obtaining the necessary matter from medicine from cellulose, Professor A.S. Turaev works on cellulose sulfite ethers, Professor K. Rozikov works on electro-microscopic structure of cotton fibers, Professor A. Sarimsakov is working on creating technology for producing cellulose microcrystal. [1,2]

### **Classification of experiments of world scientists on cotton cellulose**

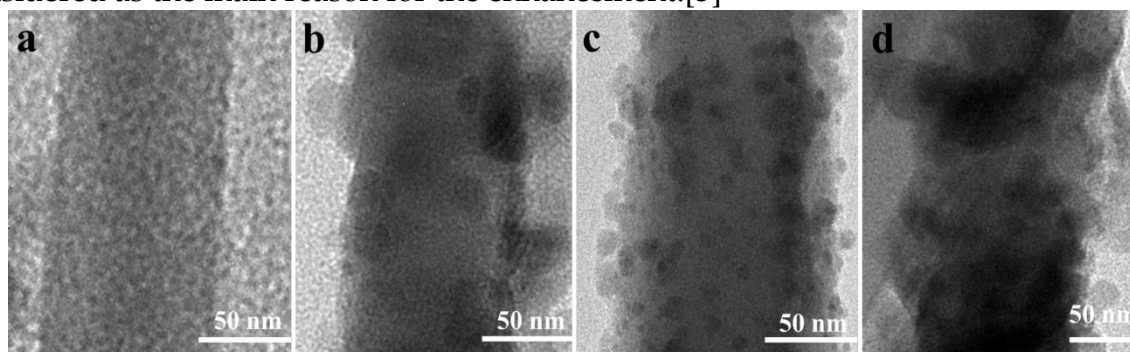
**1. Xiufang Zhang<sup>a</sup>, Jie Mei<sup>b</sup>, Song Wang<sup>a</sup>, Yingying Zheng<sup>a</sup>, Can Cui<sup>a</sup>, Jiaqi Pan<sup>a</sup>, Chaorong Li<sup>a</sup>, The recyclable cotton cellulose nanofibers/ZnO/CuS nanocomposites**

**with enhanced visible light photocatalytic activity [Text] / Journal of Materials Science: Materials in Electronics. March 2017, Volume 28. Issue 6, -pp 4669–4675**

a- Department of Physics, and Key Laboratory of ATMMT ministry of Education, Zhejiang Sci-Tech University, Hangzhou 310018, P. R.China.

b- School of Chemistry & Bioengineering, Taizhou College of Nanjing Normal University, P. R.China.

The cotton cellulose nanofibers (CCNFs)/ZnO/CuS nanocomposites have been successfully fabricated by the electrospun-hydrothermal method and successive ionic layer adsorption. The results of XRD, SEM and TEM indicate that the CuS are successfully combined with the ZnO. The photocatalytic activity of the CCNFs/ZnO/CuS nanocomposites is investigated by the degradation of methylene blue under visible light irradiation, and it is demonstrated to be significantly enhanced after the CuS is introduced. Furthermore, the direct interfacial charge transfer of the ZnO/CuS is considered as the main reason for the enhancement.[3]



**1. Fig. S1 The TEM images of different samples. (a) C-Zn-Cu-0, (b) C-Zn-Cu-1,(c) C-Zn-Cu-2, (d) C-Zn-Cu-3**

**1. Kanza Hina, Hantao Zou, Wu Qian, Danying Zuo, Changhai Yi, Preparation and performance comparison of cellulose-based activated carbon fibres [Text] / Cellulose. –January 2018. –Volume 25. –Issue 1. –pp. 607-617**

Activated carbon fiber (ACF) is widely used sorbent material for wastewater treatment. Three natural cellulosic fibers (kapok, cotton, and ramie) and three regenerated cellulosic fibers (bamboo fiber, viscose, and Iyocell) are used to prepare ACFs using chemical activation. These ACFs are characterized using scanning electron microscope, X-ray diffraction (XRD), Fourier transform infrared spectroscopy (FTIR) testing, elemental analysis, adsorption property and nitrogen adsorption–desorption. XRD and FTIR spectrum of all six cellulosic ACFs are almost similar showing that ACFs have almost same chemical and physical composition. All cellulosic ACFs are constituted of C, H, ash and O, but C content is higher in natural cellulosic fibers. Surface morphology and surface area of cellulosic ACFs play the basic role in adsorption. The 2nd order pseudo kinetic model is fitted for all cellulosic ACFs as  $R^2 > 0.99$  and adsorption

controlling process is chemical sorption. The adsorption capacity of the kapok-based ACFs is best, owing to their hollow structure, the micro pores on surface and high specific surface area. Bamboo, ramie and cotton based ACFs also have high adsorption but they need more time to adsorb impurities than kapok based ACFs. Viscose based ACFs shows moderate adsorption, while the least adsorption is shown by the Iyocell based ACFs because of their smooth and uniform structure. Adsorption analysis and other properties evaluation show that kapok fiber is the best precursor than other five cellulosic fibers.[4]

**1. Grunin Yu.B., Grunin L.Yu., Gal'braikh L.S., Sheveleva N.N., Masas D.S., Dispersion Peculiarities of Crystalline Cellulose Upon its Moistening [Text] / Fiber Chemistry. -January 2018. -Volume 49. -Issue 5. -pp. 321-326**

A modernized scheme of the structure of native cotton cellulose micro fibrils is proposed, providing for the presence of slit-shaped pores in its structure and satisfying most of the results of modern studies of its supramolecular structure and sorption properties. It is shown that within the framework of this scheme it is possible to determine the content of elementary fibrils in micro fibrils and the degree of crystallinity of cellulose using <sup>1</sup>H-NMR and sorption measurements. The mechanism and character of dispersion of micro fibrils, accompanied by supramolecular rearrangements of moistened cellulose, was investigated.[5]

**2. Mikhail A.T., Vasiliy I.M., Elena V.U., Lyudmila A.A., Andrey I.P., Nikolay V.T., Pavel V.K., Cellulose nanocrystals with different length-to-diameter ratios extracted from various plants using novel system acetic acid/phosphotungstic acid/octanol-1 [Text] / Cellulose. -February 2018. -Volume 25. -Issue 2. -pp. 1031-1046**

The novel system [acetic acid/ phosphotungstic acid (H<sub>3</sub>PW<sub>12</sub>O<sub>40</sub>)/octanol] was proposed for catalytic solvolysis of cellulose and for obtaining cellulose nanocrystals (CNC). Several alternative experiments involving mixtures with different compositions were carried out; reaction time was also varied. CNC particles from cotton, linen, softwood and hardwood cellulose were prepared in the experiments performed for 40 min in the presence of 0.25 mol% of the heteropolyacid. CNC samples were characterized by transmission electron microscopy and atomic force microscopy, X-ray diffraction analysis, and thermogravimetric analysis. It was established that the resulting nanoparticles had high crystallinity and rod-like shape; their length varied from 160 to 400 nm (cotton CNC had the shortest length, and linen CNC had the longest length), and CNC thickness ranged from 6 to 10 nm. Thermal stability of CNC was lower than that of initial celluloses and decreasing in the following sequence: *cotton > softwood > hardwood > linen cellulose*.[6]

**3. <sup>1</sup>Ravindra D. Kale, <sup>1</sup>Prabhat Shobha Bansal, <sup>1</sup>Vikrant G. Gorade, Extraction of Microcrystalline Cellulose from Cotton Sliver and its Comparison with Commercial Microcrystalline Cellulose [Text] / Journal of Polymers and the Environment. -January 2018. -Volume 26. -Issue1. -pp. 355-364**



Department of Fibers and Textile Processing Technology, Institute of Chemical Technology, Mumbai, India.

The work was aimed at the extraction of microcrystalline cellulose (EMC) from raw cotton sliver (RCS) by acid hydrolysis using sulphuric acid. The EMC was characterized and compared with commercial grade microcrystalline cellulose (CMC). Basic chemical pretreatments, bleaching and scouring were given to the RCS before extraction to remove natural colourants and hydrophobic impurities like oils, waxes, minerals, fats etc. The properties of EMC and CMC are considerably different from the RCS. Average particle size obtained was around 5–10  $\mu\text{m}$  for EMC and CMC respectively. The EMC suspension was more stable than CMC suspension. The RCS, EMC and CMC were characterized by using X-ray diffraction, thermogravimetric analysis, Fourier transform infrared spectroscopy, scanning electronic microscopy and contact angle. EMC prepared from RCS has properties at par with CMC. Cotton being rich in cellulose content can be potentially used as the source for micro cellulose extraction, particularly in the production of hydrophilic micro composites.[7]

**4. Kim H.J., Liu. Y., Alfred D., Christopher M., Kim H., Comparison and validation of Fourier transform infrared spectroscopic methods for monitoring secondary cell wall cellulose from cotton fibers [Text] / Cellulose. January 2018. Volume 25. –pp. 49-64**

The amount of secondary cell wall (SCW) cellulose in the fiber affects the quality and commercial value of cotton. Accurate assessments of SCW cellulose are essential for improving cotton fibers. Fourier transform infrared (FT-IR) spectroscopy enables distinguishing SCW from other cell wall components in a rapid and non-invasive way. Thus it has been used for monitoring SCW development in model plants. Recently, several FT-IR methods have been proposed for monitoring cotton fiber development. However, they are rarely utilized for assessing SCW cellulose from cotton fiber due to limited validation with various cotton species grown in different conditions. Thus, we compared and validated three FT-IR methods including two previously proposed methods analyzing entire spectra or specific bands as well as a new method analyzing FT-IR spectral regions corresponding to cellulose with various cotton fibers grown in planta and in vitro. Comparisons of the FT-IR methods with reference methods showed that the two FT-IR methods analyzing the entire spectra or cellulose regions by principal component analysis monitored SCW qualitatively, whereas the FT-IR method analyzing specific bands (708, 730, and 800  $\text{cm}^{-1}$ ) by a simple algorithm allowed the monitoring of SCW cellulose levels quantitatively. The quantitative FT-IR method is a potential substitute for lengthy and laborious chemical assays for monitoring SCW cellulose levels from cotton fibers, and it can be used for a better understanding of cotton fiber SCW development and as a part of the quality assessment tools used to guide choices for improving fiber quality.[8]

5. Jiaqi Pan, Xiufang Zhang, Jie Mei, Song Wang, Mingzhu You, Yingying Zheng, Can Cui, Chaorong Li, **The cotton cellulose nanofibers framework of Z-Scheme ZnO/Ag<sub>3</sub>PO<sub>4</sub> heterojunction for visible-light photocatalysis** [Text] / Cellulose. January 2018. Volume 25. –pp. 73-79

The cotton cellulose nanofibers framework of Z-Scheme ZnO/Ag<sub>3</sub>PO<sub>4</sub> heterojunction has been successfully fabricated by a simple route of the electrospun-hydrothermal method. The photocatalytic activity of the as-prepared cotton cellulose nanofibers framework of Z-Scheme ZnO/Ag<sub>3</sub>PO<sub>4</sub> heterojunction exhibits significant enhancement after the Ag<sub>3</sub>PO<sub>4</sub> being introduced by the degradation of methylene blue (MB) under visible light irradiation. Furthermore, the high dispersibility of the CCNFs, high visible light absorption and photon-generated carriers separation of Z-Scheme ZnO/Ag<sub>3</sub>PO<sub>4</sub> heterostructure are considered as the main reasons for the enhancement.[9]

#### **Experimental, Preparation of CCNFs/ZnO/ CCNF/ZnO/Ag<sub>3</sub>PO<sub>4</sub> nanocomposites**

The CCNFs were obtained by electrospinning process according to our previous work. The growth of ZnO nanorod has been achieved by hydrothermal synthetic method. Firstly, the cotton nanofibers were drop-coated 15 times with 20mM zinc acetate (Zn(CH<sub>3</sub>COO)<sub>2</sub>•2H<sub>2</sub>O) ethanol solution and annealed at 150°C for 3 h to get the ZnO seed layer. Then, the CCNFs with ZnO seed layer was placed in a 30 ml autoclave containing an aqueous solution of 25 mMol Zn(NO<sub>3</sub>)<sub>2</sub>•6H<sub>2</sub>O and 25 mMol HMTA. the autoclave was sealed in an electric oven under 90°C for 10 h. Finally, Ag<sub>3</sub>PO<sub>4</sub> nanoparticles were deposited on CCNFs/ZnO by ordinary precipitation method. The as-prepared CCNFs/ZnO were immersed in an aqueous solution with different concentration of AgNO<sub>3</sub> (0.009 M, 0.018 M, 0.027M, 0.036 M), then corresponding stoichiometric amount of Na<sub>3</sub>PO<sub>4</sub> (0.006 M, 0.012 M, 0.018 M, 0.024 M) was added dropwise to the solution. After the resulting solution was magnetically stirred for 10 min, the as-prepared samples with different concentration of AgNO<sub>3</sub> (0.009 M, 0.018 M, 0.027M, 0.036 M) are marked as CCNFs/ZnO/Ag<sub>3</sub>PO<sub>4</sub>-X (X=0, 1, 2, 3).[9]

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