

The work is aimed at obtaining carbon nanofibers from domestic raw materials, which are used in organizations in the field of ecology, nature protection, medicine and pharmaceuticals, devices for generating and storing electricity, construction and building materials, aircraft, ship and machine building, military space industry. The prospect of these studies lies in the possibility of large-scale production of carbon nanofibers from carbon-containing raw materials, which will lead to the appearance of domestically produced materials and composites on the Kazakhstan market.



Bolat Toleukhanuly Yermagambet
Maira Kuttybaevna Kazankapova
Assemay Turlankyzy Nauryzbayeva

Carbon nanofibers for various functional purposes

based on carbon-containing raw materials

Yermagambet B. T. – Director of LLP "Institute of Coal Chemistry and Technology", Doctor of Chemical Science.
Kazankapova M. K. - PhD in Philosophy, LLP "Institute of Coal Chemistry and Technology".
Nauryzbayeva A. T.- Master of Engineering Science, Junior Researcher of LLP "Institute of Coal Chemistry and Technology".

FOR AUTHOR USE

Yermagambet, Kazankapova, Nauryzbayeva



**Bolat Toleukhanuly Yermagambet
Maira Kuttybaevna Kazankapova
Assemay Turlankyzy Nauryzbayeva**

**Carbon nanofibers for various
functional purposes**

based on carbon-containing raw materials

FOR AUTHOR USE ONLY

LAP LAMBERT Academic Publishing

Imprint

Any brand names and product names mentioned in this book are subject to trademark, brand or patent protection and are trademarks or registered trademarks of their respective holders. The use of brand names, product names, common names, trade names, product descriptions etc. even without a particular marking in this work is in no way to be construed to mean that such names may be regarded as unrestricted in respect of trademark and brand protection legislation and could thus be used by anyone.

Cover image: www.ingimage.com

Publisher:

LAP LAMBERT Academic Publishing

is a trademark of

International Book Market Service Ltd., member of OmniScriptum Publishing Group

17 Meldrum Street, Beau Bassin 71504, Mauritius

Printed at: see last page

ISBN: 978-620-2-92275-3

Copyright © Bolat Toleukhanuly Yermagambet,
Maira Kuttybaevna Kazankapova, Assemay Turlankyzy Nauryzbayeva
Copyright © 2020 International Book Market Service Ltd., member of
OmniScriptum Publishing Group

FOR AUTHOR USE ONLY

Authors: Doctor of Chemical Sciences, prof. Ermagambet B.T., PhD, Kazankapova M.K., Doctor of Chemical Sciences, prof. Kasenov B.K., Nauryzbayeva A.T., Maslov N.A., Kasenova Zh.M.

C - ___ Carbon nanofibers for various functional purposes based on carbon-containing raw materials. Monograph / Yermagambet B.T., Kazankapova M.K., Kasenov B.K., Nauryzbayeva A.T., Maslov N.A., Kasenova Zh.M. - Nur-Sultan: Institute of Coal Chemistry and Technology LLP, 2020. - 100 p.

ISBN 978-620-2-92275-3

The monograph is devoted to the development of technology for the production of composite nanofibers of various functional purposes by processing carbon-containing raw materials and the study of their physicochemical properties. The results of the study of the physicochemical and electrophysical properties of the obtained products are described. A technology for producing carbon nanofibers based on coal tar, polymers (PMMA, PAN), textile cord, rubber shavings, shale tar has been developed and tested for purification of waste water and gases.

The monograph is intended for scientific workers, specialists engaged in the deep processing of carbon-containing raw materials, nanotechnology, and can also be useful for teachers and students of educational institutions of the corresponding profile.

Recommended for publication by the Scientific and Technical Council of the Institute of Coal Chemistry and Technology.

**© Yermagambet B.T., Kazankapova M.K.,
Kasenov B.K., Nauryzbayeva A.T., Maslov N.A.,
Kasenova Zh.M. 2020**

CONTENT

Abbreviations and symbols	4
Introduction	5
1 Analytical review of methods for producing carbon nanofibers	7
1.1 General information and characteristics of carbon nanofibers	7
1.2 Basic properties of carbon nanofibers	10
1.3 Prospects for the use of carbon nanofibers	12
1.4 Methods of obtaining and production technology of nanofibers	20
1.5 Composite nanofibers based on carbon-containing raw materials	28
1.6 Future Trends and Challenges in Nanofiber Production	32
1.7 World and domestic market of carbon nanofibers	36
2 Technique for obtaining carbon nanofibers	39
2.1 Raw material base for the production of carbon nanofibers	39
2.2 Sample preparation for obtaining composite nanofibers based on carbon-containing raw materials	40
2.3 Synthesis of carbon nanofibers by electrospinning	42
2.3.1 Carbon nanofibers based on coal tar	44
2.3.2 Carbon nanofibers based on coal tar pitch	45
2.3.3 Composite carbon nanofibers based on coal tar and nano iron	45
2.3.4 Carbon nanofibers based on shale tar	46
2.3.5 Carbon nanofibers based on textile cord	46
2.3.6 Carbon nanofibers based on rubber shavings	46
2.3.7 Carbon nanofibers based on coal tar and PAN	47
2.3.8 Carbon nanofibers based on humic acid and PAN	47
3 Investigation of the physicochemical characteristics of carbon nanofibers	48
3.1 Research methods	48
3.2 Study of the chemical composition, surface morphology, structural and functional features, the degree of graphitization of carbon nanofibers	50
4 Research of the electrophysical properties of carbon nanofibers	75
4.1 Research methods	75
4.2 Dependences of electrical resistance, electrical capacity and dielectric constant of carbon nanofibers on temperature	78
5 Approbation of the obtained composite carbon nanofibers	85
6 Material balance and technological scheme of technology for producing carbon nanofibers	87
7 The economic part. Calculation of the cost of carbon fiber based on coal tar	90
Conclusion	94
List of used literature	96

Abbreviations and symbols

CNM	Carbon nanomaterials
CF	carbon fiber
CNF	carbon nanofiber
SEM	Scanning Electron Microscopy
PMMA	polymethylmethacrylate
g	gram
mg	Milligram
°C	Celsius degree
PAN	polyacrylonitrile
RLS	Raman light scattering
CT	coal tar
CTP	coal tar pitch
TC	textile cord
RS	rubber shavings
CS	carbon spheres
HA	humic acid

FOR AUTHOR USE ONLY

INTRODUCTION

Today, in order to reduce dependence on imports or exports of oil and natural gas, most countries are striving to actively develop coal chemistry, namely, they are actively developing modern technologies for deep processing of coal and creating materials and products of a new generation based on different grades of coal.

Coal is one of the leading elements of the modern world fuel and energy balance. However, it has now ceded its leading position to oil and gas as a fuel. It became not profitable to simply burn it, it is much more efficient to process coal and then sell finished products or semi-finished products. It should be noted that the products obtained by deep processing are several times more expensive than the initial raw materials.

At present, modern science with the help of advanced technologies makes it possible to obtain from coal more than 100 types of chemical intermediates (phenol, cresol, alcohol, bitumens, benzenes, pitches, etc.), which are subsequently used for the production of over 5 thousand types of products, including includes not only medicines, technical gas mixtures, carbon adsorbents, fibers and composite materials, but also much more.

Now it is important to understand which methods and technologies in the field of deep coal processing will be prioritized and will have a positive impact on economic growth. Based on the above, the goals and objectives of the forthcoming work were formulated.

For the first time, we have obtained carbon nanofibers (CNF) based on coal tar, shale tar, textile cord, rubber shavings by electrospinning. The novelty of research lies in the optimization of physical and chemical processes and finding the optimal conditions for the production of carbon fibers by electrospinning based on coal tar, textile cord and rubber shavings, which are waste materials of the chemical industry. Due to the unique combination of low density, high mechanical strength at elevated temperatures, high thermal shock resistance and ablation resistance, carbon fibers are widely used in manufacturing.

One of the aspects of the novelty of these studies is the development of a technology for producing carbon nanofibers without the use of polymer precursors, which will solve the environmental aspect of the disposal of these types of waste, reduce the harmful impact on the environment with obtaining an economically viable product.

The work is aimed at obtaining carbon nanofibers from domestic raw materials, which are used in organizations in the field of ecology, nature protection, medicine and pharmaceuticals, devices for generating and storing electricity, construction and building materials, aircraft, ship and machine building, military space industry.

Today, there is no industrial production of carbon nanofibers in Kazakhstan, they are forced to purchase all types of nanofibers abroad, they are mainly purchased from Russia, Japan, the USA, Germany and China at inflated prices, and

today they amount to several thousand tons per year and have a tendency to constant growth.

At the same time, Kazakhstan has all the resources necessary for production. Own production will allow producing inexpensive and high-quality products that can replace imported ones. The well-established production of carbon nanofibers will provide Kazakhstan with efficient and inexpensive domestic CNFs.

The prospect of these studies lies in the possibility of large-scale production of carbon nanofibers from carbon-containing raw materials, which will lead to the appearance of domestically produced materials and composites on the Kazakhstan market.

FOR AUTHOR USE ONLY