

REVIEW

of official reviewer, PhD, Sharipova Altynay Azigarovna for the PhD thesis of Seitzhanova Makpal Azizovna on the topic: "Synthesis and application of membrane technology for desalination of seawater", submitted for the degree of Doctor of Philosophy (PhD) in specialty 6D074000 - Nanomaterials and nanotechnology.

1. The Relevance of the research topic and its relationship with general scientific and national programs

Graphene-based membranes are widely considered as promising materials for water treatment application due to their high water permeability, stability in water, high specific surface area, hydrophilicity and antifouling performance. As a result, significant progress has been made during the past few years in the developing of high permeable membranes, which has more advantages in comparison with conventional membranes. However, due to the high cost of graphene, the use of it for the practical application can be limited. Therefore, the use of agricultural waste, like rice husks is available and inexpensive source for the obtaining of graphenes, which makes the process cheaper, utilize rice waste and solve some environmental problems.

The thesis is devoted to solving a number of actual problems, namely, the development of a technique for the synthesis of graphene membranes from rice husks and its application for desalination of seawater.

The PhD thesis is not related to any general scientific and national programs.

2. Scientific results and their validity

The research was carried out in accordance with the objectives of the study and the following new scientific results were obtained:

1. Graphene materials from rice husks are obtained, where carbonization/activation of rice husk leads to the formation of a mixture of graphene layers and amorphous carbon. It is determined that in samples Gr(1/5) and Gr(1/4), the I_G/I_{2D} ratio is close to 1.56 ± 0.10 , which proves the 4-5-layer structure of graphene.

2. It is determined that obtained graphene materials are highly porous with an average pore size < 100 nm, and have a specific surface area of 2500-3000 m^2/g .

3. The optimal methods and conditions for the graphene membranes producing are obtained.

4. It is revealed that membranes based on graphene materials obtained from rice husks desalinate sea water till 99%.

3. The degree of validity and reliability of each scientific result (scientific position), conclusions of the applicant, formulated in the dissertation

The validity and reliability of each scientific result, conclusions of the dissertation as a whole is provided by a set of experimental data obtained on the basis of a complex of modern physicochemical methods for studying systems combined with modern literature data, by a scientifically based construction of the theoretical and experimental parts of the dissertation.

Scientific results are obtained using modern methods and analysis, such as Scanning and transmission electron microscopy, X-ray diffraction, Raman spectroscopy, mass-spectroscopy, elemental analysis, thermogravimetric analysis, infrared spectroscopy and etc.

4. The degree of novelty of each scientific result (position), conclusions of the applicant, formulated in the dissertation

The novelty of the results and conclusions formulated in the thesis is not in doubt.

The result 1 is a new because a simpler and more environmentally friendly method for graphene materials obtaining from rice husks by carbonization and chemical activation is proposed.

The result 2 is a new because the pattern of synthesis of graphene materials depending on the temperature and time of carbonization and chemical activation are revealed. The obtained graphene materials have the maximum specific surface area, determined by BET method was 2818 m²/g.

The result 3 is a new because the possibility of obtaining of new nanoporous membranes for desalination of sea water by synthesis of graphene membranes based on rice husks are shown.

5. Practical and theoretical significance of scientific results

The research is aimed at satisfying of the social demand for the water treatment by desalination and also meets the needs of the economy and industry of the Republic of Kazakhstan in science-intensive technologies and materials of the new generation.

Vacuum filtration graphene membranes are able to desalinate seawater up to 99% and can adsorb heavy ions in water. They can be used as sorbents and filters of treatment facilities, for the manufacture of supercapacitor electrodes.

The theoretical value of obtained results is to deepen study an understanding of main regularities of synthesis of membranes based on graphene and graphene oxide by vacuum filtration and immersion precipitation.

6. Comments, suggestions on the dissertation

There are the following comments and suggestions in the thesis:

1. You have studied several samples, for example Gr(1/5), Gr(1/4) and others, however when you have determined the specific surface area by BET method, which is one of the important method and gives specific information about the properties of graphenes, you have studied only one Gr(1/5), and for the comparison samples RH and CRH. Did you study Gr(1/4) sample too? If yes, what the specific surface are of it? Please explain why there is such big difference of specific surface area (more than 10 times) and the average pore size between Gr(1/5) and RH, CRH?

2. You have presented your obtained results as cheap and available materials. Did you make any calculation of the obtained membranes? What is the estimated cost of the membranes you've developed? What is the yield of graphene membranes from rice husk? What kind of approbation of your obtained results was done for the confirmation of the effectiveness of membranes?

3. How can you explain the mechanism of desalination process by obtained graphene based membranes? It is better not only to show the types of modes of systems but also explain and show what modes is appropriate for your system and explain why. It is not clear why you have shown in the end of your thesis some literature information about membranes fouling without supporting by experimental data?

4. The big amount of experimental work was done in the thesis. Did you use any theoretical model to fit experimental results?

5. It is necessary to clearly describe the scientific justification of the relationship structure-property of the obtained material based on modern view about nanoscience

6. The list of references is not formatted and there are some stylistic and grammatical errors in the work.

However, these shortcomings are not fundamental in nature and in no way diminish the merits of the dissertation.

7. Compliance of the dissertation content within the framework of the Rules for awarding of academic degrees

PhD thesis of Seitzhanova M.A. is a completed study carried out in the relevant field of nanotechnology. The dissertation is well designed, physico-chemical studies have been carried out very carefully and well described, the literary review corresponds to the topic of the dissertation.

Based on the foregoing, the dissertation "Synthesis and application of membrane technology for desalination of seawater" on its relevance, scientific novelty, theoretical and practical importance, the experimental level of the research, fully meets the requirements of the section of the "Rules of awarding scientific degrees" of the Committee for Supervision and Certification in the field of education and science, and its author is Seitzhanova M.A. deserves the award of a Doctor of Philosophy (PhD) degree in specialty 6D074000 - Nanomaterials and nanotechnology.

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