

Review of the official reviewer

for the dissertation of Houbi Anas "Creating and studying new composite materials for microwave absorption in the range of 8,8-12 GHz", specialty "8D07104 - Chemical technology of inorganic substances", submitted for the degree of Philosophy Doctor by speciality «6D072000 - Chemical technology of inorganic substances»

№	Criteria	Eligibility (one of the options must be checked)	Justification of the position of the official reviewer
1.	The topic of the thesis (as of the date of its approval) corresponds to the directions of development of science and/or state programs	<p>1.1 Compliance with priority areas of science development or government programs:</p> <p>1) The thesis was completed within the framework of a project or target program financed from the state budget (indicate the name and number of the project or program)</p> <p>2) The thesis was completed within the framework of another state program (indicate the name of the program)</p> <p>3) <u>The dissertation corresponds to the priority direction of the development of science, approved by the Higher Scientific and Technical Commission under the Government of the Republic of Kazakhstan (indicate the direction)</u></p>	<p>Corresponds</p> <p>Dissertation work is devoted to the creation and research of new composite materials for microwave absorption in the range of 8.8-12 GHz. The topic of the dissertation corresponds to one of the priority directions of science development approved by the Higher Scientific and Technical Commission for 2020-2024: "Scientific research in the field of natural sciences".</p>
2.	Importance for science	<p>The work <b>makes</b>/does not make a significant contribution to science, and its importance is well <b>disclosed</b>/not disclosed</p>	<p>This thesis work makes a significant contribution to science. The work is devoted to obtaining new composite materials for microwave absorption in the range of 8.8-12 GHz. The importance of these materials for public protection and electronic security is revealed. The results have expanded the known knowledge in the field of electromagnetic interference shielding materials and MAMS for suppressing electromagnetic interference and improving the efficiency of electronic devices.</p>
3.	The principle of independence	<p>Self-reliance level:                      1) <b>High</b>;                      2) Medium;                      3) Low;</p>	<p>The author's level of autonomy consisted in processing and analysing the literature data on the thesis topic, direct planning and implementation of the experimental part. The applicant was potentially involved in the</p>

		analysis, interpretation and presentation of the research results, and their discussion, as well as in the preparation of scientific articles.
4.	<p>The principle of inner unity</p> <p>4) No independence</p> <p>4.1 Justification of the relevance of the thesis:  1) <b>Justified;</b>  2) Partially justified;  3) Not justified.</p> <p>4.2 The content of the thesis reflects the topic of the thesis:  1) <b>Reflects;</b>  2) Partially reflects;  3) Does not reflect</p> <p>4.3. The purpose and objectives correspond to the topic of the thesis:  1) <b>correspond;</b>  2) partially correspond;  3) do not correspond</p> <p>4.4 All sections and provisions of the thesis are logically interconnected:  1) <b>completely interconnected;</b>  2) the interconnection is partial;  3) there is no interconnection</p> <p>4.5 The new solutions (principles, methods) proposed by the author are reasoned and evaluated in comparison with the known solutions:  1) <b>there is a critical analysis;</b></p>	<p>The author justifies the relevance of the thesis. The undesirable effects of modern technology causing electromagnetic interference, thereby having a dangerous impact on human health, intelligent devices, telecommunication devices and the military industry are noted. The importance for public safety and electronic security achieved by the author's research is noted. Of interest is the research pertaining to improving SE and SD by introducing CB and CI to hybrid nanocomposites, which enabled the thesis author to obtain 99.9% microwave absorption.</p> <p>The content of the thesis fully reflects the aim, objectives, and topic of the study. The illustrative material available (drawings, graphs, charts) complements the work and confirms the conclusions drawn by the author.</p> <p>In the thesis the author has clearly formulated the aim and objectives of the research, which are fully in line with the theme of the thesis. The ways of realising the objectives as well as achieving the goal are logical and justified and reveal all the main aspects of the research.</p> <p>The sections of the thesis are interconnected with each other, The structure of the thesis is competently structured in terms of scientific research.</p> <p>Conclusions are drawn for each section of the thesis, which contain a critical analysis and the author's opinion on the results obtained. The methods,</p>

		<p>2) partial analysis;  3) the analysis does not represent one's own opinions, but quotes from other authors</p>	<p>techniques and solutions used by the author are fully justified.  Methods of producing new composite materials are described step by step. The entire process is illustrated with photographs and diagrams, which fully visualise the technology of the synthesis process of new composite materials.  Author's publications in ranked scientific journals: Journal of Magnetism and Magnetic Materials; «Bulletin of the University of Karaganda – Chemistry»; «Advances in Theoretical &amp; Computational Physics»; KazNU Journal. Recent Contributions to Physics; «Journal of Chemistry: Education Research and Practice».</p>
5.	Scientific novelty principle	<p>5.1 Are the scientific results and provisions new?  1) <b>completely new</b>;  2) partially new (25-75% are new);  3) not new (less than 25% are new)</p>	<p>The scientific results are completely new, a fact indicated by the results related to the minimum loading percentage of the nanocomposite in the carrier matrix. For the first time, new absorbers that can exceed the -10 dB threshold and cover the entire 8.8-12.0 GHz frequency band by adding CB and CI to hybrid nanocomposites were obtained.  The listed new scientific results are cutting-edge and world-class.  Scientific novelty is also indicated by the author's scientific publications in ranked journals: Journal of Magnetism and Magnetic Materials; «Bulletin of the University of Karaganda – Chemistry»; «Advances in Theoretical &amp; Computational Physics»; KazNU Journal. Recent Contributions to Physics; «Journal of Chemistry: Education Research and Practice».</p>
		<p>5.2 Are the dissertation findings new?  1) <b>completely new</b>;  2) partially new (25-75% are new);  3) not new (less than 25% are new)</p>	<p>The conclusions of the thesis are new and are supported by the author's publications in ranked scientific journals: Journal of Magnetism and Magnetic Materials; «Bulletin of the University of Karaganda –</p>

<p>Chemistry; «Advances in Theoretical &amp; Computational Physics; KazNU Journal. Recent Contributions to Physics; «Journal of Chemistry: Education Research and Practice.</p>	<p>The solutions proposed in this dissertation research are a priority in the preparation of radio-absorbing materials and can be commercialised subsequently.</p> <p>The author's publications in top-rated scientific journals are proof of this: Journal of Magnetism and Magnetic Materials; «Journal of Chemistry: Education Research and Practice.</p>	
<p>5.3 Technical, technological, economic or management decisions are new and reasonable:</p> <ol style="list-style-type: none"> <li>1) <b>completely new</b>;</li> <li>2) partially new (25-75% are new);</li> <li>3) not new (less than 25% are new)</li> </ol>	<p>All main conclusions are/are not based on scientifically significant evidence or well-grounded (for qualitative research and areas of training in the arts and humanities)</p>	
<p>6. The validity of the main findings</p>	<p>It is necessary to answer the following questions for each provision separately: 7.1 Is the provision proven?</p> <p><b>Provision №1.</b></p> <ol style="list-style-type: none"> <li>1) <b>proven</b>;</li> <li>2) rather proven;</li> <li>3) rather not proven;</li> <li>4) not proven</li> </ol> <p>7.2 Is it trivial?</p> <ol style="list-style-type: none"> <li>1) yes;</li> <li>2) <b>no</b></li> </ol> <p>7.3 Is it new?</p> <ol style="list-style-type: none"> <li>1) <b>yes</b>;</li> <li>2) no</li> </ol> <p>7.4 Application level:</p> <ol style="list-style-type: none"> <li>1) narrow;</li> <li>2) medium;</li> <li>3) <b>wide</b></li> </ol>	<p>Comments:</p>
<p>7. The main provisions for the defense</p>	<p><b>Provision №1.</b></p> <p><i>Increasing the metal ions to citrate acid and PVA concentration in the ferrite leads to lower frequencies. This allows the position of the fm to be controlled.</i></p> <p>The position is proven, so the shift of the RL attenuation peaks of the samples to lower frequencies is facilitated by the size of the crystallites of the ferrite nanoparticles. The size effect of the system allows to control the position of the fm transmitter. The results are confirmed by means of state-of-the-art scientific equipment. Results validated by: Journal of Magnetism and Magnetic Materials.</p>	<p>Comments:</p>

7.5 Is it proven in the article?

- 1) yes;
- 2) no

**Provision №2.**

- 1) proven;
- 2) rather proven;
- 3) rather not proven;
- 4) not proven

7.2 Is it trivial?

- 1) yes;
- 2) no

7.3 Is it new?

- 1) yes;
- 2) no

7.4 Application level:

- 1) narrow;
- 2) medium;
- 3) wide

7.5 Is it proven in the article?

- 1) yes;
- 2) no

**Provision №3.**

- 1) proven;
- 2) rather proven;

When considering the size effect of ferrite nanoparticles, it would be interesting to assess the distribution of these nanoparticles in the volume of the composite material.

**Provision №2.**

*The synergistic incorporation of magnetic loss and dielectric loss materials leads to decreasing the loading percentage of the absorber in the host matrix, increasing the absorption BW-10 dB, and enhancing the SEmax of the absorbers to cover most of the frequency band of 8.8–12.0 GHz.*

The author created new absorbers by incorporating materials with magnetic and dielectric losses, which helps to reduce the loading percentage, while at the same time contributing to an increase in BW-10 dB absorption. The resulting composite materials with the achieved absorption capacity cover most of the frequency band in the 8.8-12.0 GHz range. The results were obtained, confirmed and published: KazNU Journal. Recent Contributions to Physics.

Comments:

The reasons for the synergistic effect of magnetic and dielectric losses on the degree of loading are not specified.

**Provision №3.**

*The reflection loss peaks of nanocomposites lead to moving to higher frequencies by increasing the PANI in*

- 3) rather not proven;  
 4) not proven  
 7.2 Is it trivial?  
 1) yes;  
 2) no  
 7.3 Is it new?  
 1) yes;  
 2) no  
 7.4 Application level:  
 1) narrow;  
 2) medium;  
 3) wide  
 7.5 Is it proven in the article?  
 1) yes;  
 2) no

*the nanocomposites. This allows for controlling the absorption bandwidth, reflection loss, and matching the frequency of the absorbers.*

The applicant obtained microwave absorbers that rival commercial absorbers in important characteristics: mass, RL, SE, and BW-10 absorption. A low nanocomposite loading percentage of 25% in the carrier matrix was achieved, one of the lowest published loading percentages. The results are reliable and valid as all measurements were carried out on calibrated instruments using standard methods. The prepared samples were structurally characterised using XRD, FTIR, TGA and EDX.

Methods of producing new composite materials are described step by step. The entire process is illustrated with photographs and diagrams, which fully visualise the technology of the synthesis process of new composite materials.

The results are published in: Bulletin of the University of Karaganda - Chemistry; "Journal of Chemistry: Education Research and Practice.

**Provision №4.**

- 1) proven;  
 2) rather proven;  
 3) rather not proven;  
 4) not proven  
 7.2 Is it trivial?  
 1) yes;  
 2) no  
 7.3 Is it new?  
 1) yes;

**Provision №4.**

*Adding CB and CI to the hybrid nanocomposites leads to improving SE and SD. This allows for obtaining 99.9% absorption to the microwave.*

A rather detailed study of the effects of CB and CI to hybrid nanocomposites. it was found and confirmed that PANI / spinel ferrite (SF) / hexagonal ferrite (HF) and PANI / SF / HF / CB nanocomposites resulting from

8.	The principle of reliability Reliability of sources and information provided	<p>2) no</p> <p>7.4 Application level: 1) narrow; 2) medium; 3) <b>wide</b></p> <p>7.5 Is it proven in the article? 1) <u>yes</u>; 2) no</p>	<p>in situ polymerisation absorb microwaves at a loading percentage of around 99.9% at 30%.</p> <p>The results are reliable and valid as all measurements were performed on calibrated instruments using standard methods.</p> <p>The prepared samples were structurally characterised using XRD, FTIR, TGA and EDX. The results are published in: Bulletin of the University of Karaganda - Chemistry; Journal of Chemistry: Education Research and Practice.</p>
	8.1 Choice of methodology - is justified or the methodology is described in sufficient detail 1) <u>yes</u> ; 2) no		<p>The methodology of the research is substantiated and described in detail by the author in the thesis.</p> <p>The author makes the relationship between the structure, composition and properties of new synthesised composite materials. In combination with the proposed new approaches to the synthesis of composite materials, the author uses modern and informative research methods. The sequence of experiments performed is logical and predetermined by the tasks of the thesis research. Standard methods are also used in the work.</p>
	8.2 The results of the thesis were obtained using modern methods of scientific research and methods of processing and interpreting data using computer technologies: 1) <u>yes</u> ; 2) no		<p>The results of the dissertation work were obtained using modern scientific research methods and an extensive instrumentation base. For the dissertation research the author used such modern methods as XRD, FTIR, TGA, EDX, etc.</p> <p>Methods of producing new composite materials are described step by step. The entire process is illustrated with photographs and diagrams, which fully visualise the technology of the synthesis process of new composite materials.</p>
	8.3 Theoretical conclusions, models, identified relationships and patterns have been proven and confirmed by experimental research (for areas of training in pedagogical sciences, the		<p>Theoretical conclusions, schemes, interrelations are revealed, regularities are proved and confirmed by experimental investigations. Empirical relationships</p>

	<p>results have been proven on the basis of a pedagogical experiment):</p> <p>1) <u>yes</u>; 2) no</p>	<p>between the structure, composition and properties of new synthesized composite materials have been established.</p> <p>The results of the work were published in ranked scientific journals: " Journal of Magnetism and Magnetic Materials; «Bulletin of the University of Karaganda – Chemistry; «Advances in Theoretical &amp; Computational Physics; KazNU Journal. Recent Contributions to Physics; «Journal of Chemistry: Education Research and Practice.</p>	
	<p>8.4 Important statements are <b>confirmed</b> / partially confirmed / not confirmed by references to current and reliable scientific literature</p> <p>8.5 Used literature sources are <b>sufficient</b>/not sufficient for a literature review</p>	<p>Important statements are supported by references to relevant and scholarly literature, mainly quality international scholarly publications from the last 20 years.</p> <p>The list of references, which includes 137 sources, demonstrates the thorough work done to analyse the issue in advance and to establish its relevance in a scientific environment.</p>	
9	<p>Practical value principle</p>	<p>9.1 The thesis has theoretical value: 1) <u>yes</u>; 2) no</p> <p>9.2 The thesis is of practical importance and there is a high probability of applying the results obtained in practice: 1) <u>yes</u>; 2) no</p>	<p>The important theoretical significance of the work lies in the results, which extend the known knowledge in the field of EMI shielding materials and MAMS for suppressing electromagnetic interference and improving the efficiency of electronic devices.</p> <p>The results of this dissertation research have important practical value in the area of MAMS for reducing noise generated by electronic circuits and smartphones, removing noise from original images on screens and making shields in microwave ovens, and making these materials for military applications to reduce the radar cross section of some military systems.</p>



		<p>9.3 Are the practice suggestions new?</p> <p>1) <b>completely new</b>;  2) partially new (25-75% are new);  3) not new (less than 25% are new)</p>	<p>All proposals described in the thesis are absolutely new, which, among other things, is confirmed by published scientific articles in scientific journals:</p>
10.	<p>The quality of writing and design</p>	<p>Academic writing quality:</p> <p>1) <b>high</b>;  2) average;  3) below average;  4) low.</p>	<p>The thesis is written in a literate, scientific language, in an accessible and professional style. The main points and conclusions are clearly stated and complete.</p>

In reviews, official reviewers indicate one of the following solutions:

- 1) to award the degree of Doctor of Philosophy (PhD) or Doctor of Specialization

**Official Reviewer:**

Acting Head of the Department of Physical Chemistry  
at Perm State National Research University

PhD

associate professor of physical chemistry department



/N.A. Medvedeva/

