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 specialty «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	1.1 Compliance with priority areas of science development or government programs:	The dissertation research and its results correspond to the priority areas of science development in several positions, these are "Geology, mining and processing of mineral and hydrocarbon raw materials, new materials, technologies, safe products and structures", "Information, communication and space technologies", "National security and defense".
		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) 2) The thesis was completed within the framework of another state program (indicate the name of the program) 3) 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)	In the dissertation work and its results, there are no references to the belonging of the implementation, within the framework of any project, to the state program, however, they correspond to the direction of development of science, approved by the Higher Scientific and Technical Commission of the Republic of Kazakhstan.
2.	Importance for science	The work makes/does not make a significant contribution to science, and its importance is well disclosed/not disclosed	The dissertation work is sufficiently disclosed and makes a significant contribution to science, in particular, in obtaining materials with a high absorption capacity of microwave radiation and a wide noise absorption band in the range of 8.8–12 GHz.

3.	The principle of independence	Self-reliance level: 1) High; 2) Medium; 3) Low; 4) No independence	Based on the examination of the dissertation work and the results obtained, published works and the review of the scientific consultant, as well as taking into account the internship at the Center for Complex Processing of Mineral Raw Materials for the synthesis of PANI, the level of independence of the applicant is assessed as high. In addition, the significant contribution of the applicant is expressed in the preparation of scientific articles, including the first authorship of an article in the Journal of Magnetism and Magnetic Materials of the first quartile (Q2) Web of Science.
4.	The principle of inner unity	4.1 Justification of the relevance of the thesis: 1) Justified; 2) Partially justified; 3) Not justified.	The dissertation work is devoted to the creation of radio absorbing materials with magnetic losses and dielectric losses in the microwave region, the frequency range of 8.8-12.0 GHz. Despite the fact that work in this direction is actively being carried out in neighboring countries and far abroad, the implementation of similar projects in Kazakhstan in order to develop new high-performance broadband radio absorbing materials is becoming very relevant for solving the problem of interference reduction and electromagnetic compatibility of devices.
		4.2 The content of the thesis reflects the topic of the thesis: 1) Reflects; 2) Partially reflects; 3) Does not reflect	The content of the dissertation reflects in detail the topic of the study; its goals and objectives; the main assumptions submitted for defense, the results and conclusions are consistent with each other and correspond to the topic of the dissertation.
		4.3. The purpose and objectives correspond to the topic of the thesis:	The goals and objectives of the dissertation

		1) correspond; 2) partially correspond; 3) do not correspond	work correspond to the research topic and reflect the content of the dissertation work.
		4.4 All sections and provisions of the thesis are logically interconnected: 1) completely interconnected; 2) the interconnection is partial; 3) there is no interconnection	The completed dissertation research is a structured, complete, integral and interconnected work with its inherent internal logic. The obtained experimental results are logical, structured and complete.
		4.5 The new solutions (principles, methods) proposed by the author are reasoned and evaluated in comparison with the known solutions: 1) there is a critical analysis; 2) partial analysis; 3) the analysis does not represent one's own opinions, but quotes from other authors	There is a critical analysis.
5.	Scientific novelty principle	5.1 Are the scientific results and provisions new? 1) completely new; 2) partially new (25-75% are new); 3) not new (less than 25% are new)	The scientific results and provisions obtained in the framework of the dissertation work are partially new and are as follows: – the ratio of metal ions to citric acid and aqueous solutions of PVA was determined for RLmin, fm and SEmax. – creation of a new absorber with magnetic and dielectric losses, allowing to increase the absorption up to BW-10 dB and increase the semax of absorbers in the frequency range of 8.8–12.0 GHz. – A low loading percentage of the PANI/Ni3+0.25Ni2+0.375Zn2+0.25Fe2O4 nanocomposite in the carrier matrix of 25% was achieved, which is one of the lowest published loading percentages in the world. – New interference absorbers have been obtained that can exceed the threshold of -

			10 dB and cover the entire frequency band of 8.8–12.0 GHz by adding CB and CI to hybrid nanocomposites.
		5.2 Are the dissertation findings new? 1) completely new; 2) partially new (25-75% are new); 3) not new (less than 25% are new)	The conclusions of the dissertation are new. The conclusions are confirmed by the results of a detailed comparative analysis of experimental data.
		5.3 Technical, technological, economic or management decisions are new and reasonable: 1) completely new; 2) partially new (25-75% are new); 3) not new (less than 25% are new)	Technical, technological, economic or management decisions are partially new and reasonable.
6.	The validity of the main findings	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)	All the main conclusions are quite well substantiated on scientifically weighty evidence.
7.	The main provisions for the defense	It is necessary to answer the following questions for each provision separately: 7.1 Is the provition proven? 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?	Provisions №1. Increasing the metal ions to citrate acid and PVA concentration in the ferrite leads the RL attenuation peaks of samples to shift to lower frequencies. This allows the position of the fm to be controlled. 7.1 Is the provition proven? 1) proven; 7.2 Is it trivial? 1) no; 7.3 Is it new? 1) yes; 7.4 Application level: 3) wide 7.5 Is it proven in the article? 2) no Provisions №2. The synergistic

		1) yes; 2) no	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. 7.1 Is the provition proven? 1) proven; 7.2 Is it trivial? 1) no; 7.3 Is it new? 1) yes; 7.4 Application level: 3) wide 7.5 Is it proven in the article? 1) yes; A Houbi, AA Zharmenov, Y Atassi Electromagnetic Interference Shielding Properties of (Ni0.5Zn0.5Fe2O4/CI/CB) Ternary Composites-Filled Paraffin Wax Matrix\\ Journal of Chemistry: Education Research and Practice.–2022.–Vol.6.–P.392–401 Provisions №3. Detecting that the RL attenuation peaks of hybrid nanocomposites moved to higher frequencies by increasing the PANI in the hybrid nanocomposites. These results lead to the possibility to control the absorption $BW_{-10\ dB}$, RL_{min}, and f_m of the absorbers. 7.1 Is the provition proven? 1) proven; 7.2 Is it trivial?

			1) no; 7.3 Is it new? 1) yes; 7.4 Application level: 3) wide 7.5 Is it proven in the article? 1) yes; Houbi A., Zharmenov, A.A., Atassi, Y., Bagasharova, Z.T., Mirzalieva, S., & Karibayev, B.A. (2022) Synthesis and Microwave Absorption Properties of $Ni_{0.5}Zn_{0.5}Fe_2O4$/CI Composite Coated with Polyaniline within Paraffin Wax Matrix. Bulletin of the University of Karaganda – Chemistry. Provisions №4. Enhancing the RL value and obtaining 99.9% absorption to the microwave with improving SE and SD by adding CB and CI to the hybrid nanocomposites. 7.1 Is the provition proven? 1) proven; 7.2 Is it trivial? 1) no; 7.3 Is it new? 1) yes; 7.4 Application level: 3) wide 7.5 Is it proven in the article? 1) yes; A Houbi, AA Zharmenov, Y Atassi Electromagnetic Interference Shielding Properties of (Ni0.5Zn0.5Fe2O4/CI/CB) Ternary

			Composites-Filled Paraffin Wax Matrix\\ Journal of Chemistry: Education Research and Practice.–2022.–Vol.6.–P.392–401
8.	The principle of reliability Reliability of sources and information provided	8.1 Choice of methodology - is justified or the methodology is described in sufficient detail 1) yes; 2) no	The choice of methodology is justified. Ferrites were prepared in this research by different methods (physical and chemical), starting from metal oxides (physical method) and metal salts (chemical methods: citrate precursor, self-combustion). The preparation of the nanocomposite (PANI/SF, PANI/HF, PANI/CI, PANI/CB, etc.) required different chemicals (monomers, oxidizers, and various chemicals). Ferrites were prepared by the ceramic sintering technique from metallic oxides to study the effect of substitution on radar absorption properties.
		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) yes; 2) no	The results were obtained using modern research methods and tested experimental techniques. In this regard, the results of the dissertation work are reliable and interpreted at a high level. In addition, the main results of the work were published in peer-reviewed scientific articles that have a high citation rate, which does not raise doubts about their reliability.
		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 results have been proven on the basis of a pedagogical experiment): 1) yes; 2) no	Based on the results of the experiments, conclusions were formulated, the relationship between the result of the experiment and the method of obtaining the material was revealed. All regularities are confirmed and verified, they

			correspond to generally recognized physical laws and are confirmed by the results of the analysis of experimental studies and their comparison with literature data.
		8.4 Important statements are <u>confirmed</u> / partially confirmed / not confirmed by references to current and reliable scientific literature	The author provides links to publications in international peer-reviewed journals and reliable, up-to-date scientific literature on the main statements.
		8.5 Used literature sources are sufficient/not sufficient for a literature review	In the review part of the work, the author used literary sources, including published articles in international peer-reviewed journals. Basically, the titles of the referenced literature are articles from journals in the Scopus, Web of Science database with good citation rates. The list of used literature is 137 titles and I think that this is enough for a literature review on this research topic.
9	Practical value principle	9.1 The thesis has theoretical value: 1) yes; <u>2) no</u>	The dissertation work presents the results of mainly experimental work with their justification, therefore, it is more of an applied nature than a theoretical one.
		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	The dissertation is of practical importance and there is a high probability of applying the results obtained in practice. The target consumers of the obtained results can be both academic institutions and manufacturing companies involved in the development of new materials for protection against electromagnetic radiation and the military defense industry.
		9.3 Are the practice suggestions new?	Suggestions for practice are quite new: The

		1) completely new; 2) partially new (25-75% are new); 3) not new (less than 25% are new)	results obtained are of practical interest for obtaining new improved nanocomposites for absorbing EM waves at the X-band frequency. In addition, the scientific level of the presented thesis complies with international standards for research conducted in the selected field. This is evidenced by a good level of publications, the presentation and the discussion of the results of work at international conferences.
10.	The quality of writing and design	Academic writing quality: 1) high; 2) average; 3) below average; 4) low.	The style of presentation corresponds to a greater extent to scientific works. In the work, the author is able to express thoughts in a concise and accessible form. The dissertation work is done at a fairly good level, it is a completed research work.

The dissertation work of Houbi Anas is a serious contribution to the development of energy storage sources. However, in terms of content and its design, there are the following wishes and comments:

1. The research results are dispersed throughout the dissertation in a very peculiar way: X-ray diffraction analyses, surface morphology, Fourier IR studies and microwave absorbing properties of all materials are divided into headings. In order to grasp the relationship between X-ray diffraction analysis of IR studies with the microwave absorbing properties of nanocomposite materials, it is necessary to return to the beginning of the dissertation.
2. The written conclusion on the dissertation work is incomplete. The above information on research methods, which are available in section 2, is repeated in conclusion.
3. The description of the FTIR spectra of $Ni_{0.5}Zn_{0.5}Fe_2O_4$ at various temperatures of 650, 800, and 950°C, as well as in various PVA aqueous solutions (1%, 4%, and 6%), is not sufficiently complete. It is not entirely clear why the temperature changed and what it led to.

The noted shortcomings and remarks do not reduce the overall positive impression of the dissertation work. The work is considered a qualified scientific work of a high level of its significance. I believe that the dissertation work meets all the requirements, so I came to the following conclusion:
1) to award the degree of Doctor of Philosophy (PhD) by specialty «6D072000 - Chemical technology of inorganic substances» Houbi Anas

Official Reviewer:
Ph.D., associated professor of
Karaganda Buketov University
(place of work, academic title)

(signature)

Timur Serikov
(FULL NAME)

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