

REVIEW

of reviewer on thesis of

Li Che

on the topic «Organo-mineral textured coatings with enhanced water repellency
(Органо-мінеральні текстуровані покриття з підвищеним
водовідштовхуванням)»,

submitted for the degree of Doctor of Philosophy

field of knowledge 16 – Chemical and Bioengineering
specialty 161 – Chemical Technology and Engineering

Relevance of the dissertation topic

The dissertation addresses a highly topical issue related to the creation of functional coatings with tunable hydrophobicity. Surfaces capable of controlled water repellency are of increasing importance in applications where moisture management, surface protection, and energy efficiency are critical—such as in building materials, electronic devices, and environmental technologies. By focusing on organo-mineral systems, the research combines the advantages of inorganic fillers and organic matrices, ensuring both mechanical stability and adjustable surface energy.

A notable feature of the study is the environmentally oriented approach based on the use of industrial by-products, specifically red mud, as a source of texture-forming particles. The transformation of this waste into a functional component represents a meaningful contribution to sustainable materials science and circular economy principles. This aspect enhances the societal relevance of the research by providing a route for waste recycling into value-added products.

Equally important is the application of technologically simple and cost-effective coating fabrication methods. The use of accessible mixing and film-forming processes ensures that the developed coatings can be produced without specialized infrastructure, which is crucial for scaling up superhydrophobic surface technologies.

This pragmatic approach makes the research results directly applicable in industrial settings, addressing one of the key barriers to the commercialization of superhydrophobic materials. Therefore, the dissertation topic is both scientifically significant and practically meaningful, addressing urgent environmental and technological challenges.

Assessment of the validity of the scientific results of the dissertation, their reliability and novelty

The scientific novelty of the dissertation research results lies in the following:

The scientific novelty of this dissertation encompasses several key aspects. Firstly, it introduces a new approach for converting red mud waste into functional texture-forming particles for hydrophobic coatings. The combination of calcination at 950 °C and silane surface modification was proven to reduce polarity and enable stable high contact angles, which had not been reported previously. Secondly, the study advances the synthesis of zinc oxide-based particles with controllable morphology through precise adjustment of temperature, acidity, and doping composition. The obtained hierarchical ZnO–TiO₂ and ZnO–SiO₂ particles exhibit superior water-repellent properties and resistance to UV-induced hydrophilization, maintaining Cassie–Baxter wetting up to 170 h of irradiation.

Another novel finding is the demonstration that superhydrophobicity can be achieved over a broad concentration range of hierarchical fillers, which simplifies formulation design and enhances scalability. The revealed relationship between filler morphology, surface energy, and wetting transition deepens the theoretical understanding of organo-mineral composites.

The reliability of the results is ensured by the use of a comprehensive analytical toolkit: SEM and TEM for morphology, XRD for phase composition, FTIR for chemical bonding, PL for photoactivity, and contact angle goniometry for wettability assessment. The consistency among these datasets confirms the validity of the interpretations. Repeated experiments and statistical averaging guarantee reproducibility. The logical coherence between microstructural features and measured macroscopic properties further strengthens the conclusions.

The results have undergone external validation through peer-reviewed publications and conference presentations. The combination of experimental evidence, theoretical justification, and independent dissemination confirms the credibility and scientific soundness of the study.

The scientific research was carried out by the applicant at the Department of Chemical Technology of Composite Materials of Igor Sikorsky Kyiv Polytechnic Institute within the scientific direction of the department under the supervision of the head of the department, Doctor of Technical Sciences, Associate Professor Oleksiy Volodymyrovych Myronyuk.

Thus, the scientific task set in the dissertation – to establish the connection between the structure and water repellency of organo-mineral surfaces – has been fully accomplished, and the candidate has fully mastered the methodology of scientific activity.

Assessment of the content of the dissertation, its completeness, and compliance with the principles of academic integrity

In terms of content, Li Che's dissertation fully complies with the Higher Education Standard for specialty 161 – Chemical Technology and Engineering and

research areas in accordance with the Chemical Technology and Engineering educational program.

The dissertation is a complete scientific work and demonstrates the applicant's personal contribution to the scientific field of developing new substances and materials.

Having reviewed the similarity report based on the results of checking the dissertation for text matches, it can be concluded that Li Che's dissertation is the result of the applicant's independent research and does not contain elements of falsification, compilation, fabrication, plagiarism, or borrowing. The ideas, results, and texts of other authors used are properly referenced to the relevant source.

Language, style, and structure of presentation

The dissertation is written in English.

The dissertation demonstrates a high standard of academic writing and logical organization. The text is presented in fluent, technically accurate English, adhering to the conventions of scientific style. The author maintains clarity and consistency across all sections, articulating complex phenomena in a comprehensible and sequential manner. The arguments are developed logically, with appropriate transitions between background theory, experimental evidence, and analytical conclusions. The narrative structure is deliberate and methodical.

The dissertation consists of an introduction, 6 chapters, conclusions, and a list of references. The total number of pages in the paper is 165, with 133 pages for the main part.

The Introduction outlines the motivation for the study, defines the aim and objectives, and introduces the novelty of using organo-mineral composites for hydrophobic coatings. The relevance is substantiated through references to environmental and technological challenges, ensuring the reader's understanding of the research context.

The first chapter provides a systematic literature review on wetting theory, surface energy concepts, and strategies for fabricating water-repellent materials. The author highlights the gap related to scalable fabrication methods and identifies the potential of combining mineral fillers with polymeric matrices.

The second chapter explains the experimental framework with exceptional clarity. Materials and reagents are described precisely, and each synthesis step is justified scientifically. The applied instrumental techniques—SEM, XRD, FTIR, PL, and contact-angle goniometry—are presented with methodological detail, demonstrating the author's proficiency in surface characterization.

The third and fourth chapters contain experimental findings structured around defined research tasks. Each result is supported by visual data and interpreted through theoretical models. The narrative maintains coherence between description and

analysis, allowing the reader to trace the evolution of ideas from observation to conclusion.

The fifth chapter integrates the obtained data into a broader discussion, connecting morphological and chemical features with wettability performance. The reasoning is rigorous, relying on correlations between structural hierarchy and hydrophobic response.

The sixth chapter examines thin organic films on textured mineral substrates, presenting a logical continuation of the main research theme. The section emphasizes the influence of surface chemistry on condensation and hydrophobicity, reinforcing the dissertation's holistic approach.

The Conclusions summarize findings in a concise and reasoned manner, emphasizing how the objectives were achieved. They are presented in a structured format that mirrors the logical flow of the work.

The linguistic presentation is academic, precise, and impartial. The terminology corresponds to international standards, and abbreviations are defined clearly. The text is free from stylistic inconsistencies and demonstrates a deep understanding of scientific discourse. The use of figures and tables enhances comprehension, and all visual elements are well-integrated into the discussion. Overall, the dissertation is well-structured, readable, and stylistically unified, reflecting the author's competence in scientific communication.

The dissertation is formatted in accordance with the requirements of Order No. 40 of the Ministry of Education and Science of Ukraine dated January 12, 2017, "On Approval of Requirements for Formatting Dissertations."

Presentation of dissertation results

The scientific results of the dissertation are presented in 6 scientific publications by the applicant, including: 4 articles in scientific journals included in the list of scientific professional publications of Ukraine at the date of publication; 2 articles in periodical scientific publications indexed in the Web of Science Core Collection and Scopus databases, of which 2 articles are in publications classified as first and second quartile (Q1–Q2) according to the SCImago Journal and Country Rank or Journal Citation Reports classification.

The results of the dissertation were also tested at 3 scientific conferences.

The applicant has a high level of scientific publications, and the results of his research have been published in professional and international journals. Ethical standards and principles of academic integrity were observed during the preparation and publication of scientific articles. The applicant's personal contribution to collective works is significant and indisputable.

Thus, the scientific results described in the dissertation are fully covered in the applicant's scientific publications.

Shortcomings and comments on the dissertation.

1. In the dissertation, several experimental procedures are employed (e.g., the synthesis procedures for ZnO and other materials indicated on p. 51). However, the text does not cite the sources of these methods, making it unclear whether they are the result of the author's preliminary work or previously described protocols.

2. In Figures 3.2 and 3.3, results are presented for thermally treated and as-received red muds. The particle size distribution curves indicate that, after treatment and sieving, the red-mud particles become at least ten times smaller than in the initial state; however, in the accompanying micrographs they appear nearly identical.

3. When presenting results for particles synthesized by different methods, the author often does not provide data for analogous starting materials; in the case of mixed systems, only one of the two components is shown in its neat form. For example, in Figure 4.4, XRD patterns for SiO₂ and TiO₂ are missing, which would be necessary for deeper understanding and interpretation.

4. In the tables reporting contact angle measurements (Tables 5.2, 5.1, etc.), the author does not indicate the measurement accuracy/uncertainty. Although values are given to one decimal place, such precision is unlikely for samples that are highly heterogeneous.

5. The manuscript contains mechanical inaccuracies, errors, and typographical issues. For example, when discussing the results of Figure 4.11, the author does not cite the figure explicitly but instead uses expressions such as "The right image, taken at higher magnification."

I consider that the comments made are not decisive and do not diminish the overall scientific novelty and practical significance of the results, nor do they affect the positive assessment of the dissertation.

Conclusion on the dissertation

I consider that the doctoral dissertation of Li Che on the topic "Organo-mineral textured coatings with enhanced water repellency" has been completed at a high scientific level, does not violate the principles of academic integrity, and is a complete scientific study, the combination of theoretical and practical results of which solves a scientific problem that is of significant importance for the field of knowledge 16 – Chemical and Bioengineering. In terms of relevance, practical value, and scientific novelty, the dissertation fully complies with the requirements of the current legislation of Ukraine, as provided for in paragraphs 6–9 of the "Procedure for awarding the degree of Doctor of Philosophy and revoking the decision of a one-time specialized academic council of a higher education institution, scientific institution on awarding the degree of Doctor of Philosophy," approved by Resolution of the Cabinet of Ministers of Ukraine No. 44 of January 12, 2022.

The applicant Li Che deserves to be awarded the degree of Doctor of Philosophy in the field of knowledge 16 – Chemical and Bioengineering specialty 161 – Chemical Technology and Engineering.

Reviewer:

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of Ceramics and Glass Department
of Igor Sikorsky Kyiv Polytechnic Institute,
Candidate of Technical Sciences,
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Viktoriia TOBILKO

14.10.2025р.

