

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 relevance of this dissertation is determined by its focus on organo-mineral textured coatings with controllable hydrophobicity, which represent a promising class of materials for contemporary engineering and environmental applications. The capacity to modulate surface wettability enables the design of coatings that can perform specific functions ranging from water repellence and self-cleaning to selective condensation and anti-corrosion protection. Such versatility is particularly important in modern industries striving for multifunctional, durable, and energy-efficient solutions.

A significant strength of the research lies in the integration of red mud - an abundant industrial waste into the composition of the coatings. The conversion of this by-product into a functional filler not only provides an environmentally responsible method of waste utilization but also contributes to reducing raw material costs. This aligns with global sustainability trends and demonstrates how industrial ecology principles can be embedded into material development.

Moreover, the work emphasizes the use of conventional, easily scalable fabrication techniques such as solution mixing and layer casting which serve as a realistic basis for large-scale production. Unlike expensive microfabrication methods, the chosen approach ensures the reproducibility and economic feasibility of the resulting coatings. Such orientation toward practical applicability significantly increases the industrial potential of the research outcomes. Hence, the dissertation addresses an important scientific and engineering problem, combining environmental benefits with technological relevance.

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:

This dissertation provides novel contributions to the science of water-repellent coatings. It is the first to demonstrate that industrial red mud, after thermal deactivation and organosilicon modification, can serve as an effective component in forming textured surfaces with hydrophobic properties comparable to traditional mineral fillers. This finding addresses both waste utilization and sustainable material development. Furthermore, the work establishes new insights into the synthesis of doped zinc oxide particles with hierarchical structures, showing that TiO_2 and SiO_2 additives control morphology and enhance hydrophobicity. The combination of these particles with polymer matrices produces coatings with contact angles up to 154° and high UV stability.

A unique aspect of the research is the discovery that hierarchical morphology ensures consistent water repellency across varying filler loadings, which distinguishes it from conventional systems. Additionally, the correlation between doping composition and photoluminescent response expands understanding of structure–property relationships in multifunctional coatings.

The reliability of the results is confirmed by a rigorous methodology involving multiple complementary characterization techniques. Structural, chemical, and optical analyses (SEM, XRD, FTIR, PL) were integrated with surface wettability measurements, providing comprehensive verification. The experiments were repeated under identical conditions, and data were statistically processed to minimize random errors.

The theoretical interpretation aligns with classical wetting models and is supported by consistent experimental evidence. The obtained conclusions are well grounded, internally coherent, and externally validated through publications in indexed journals and conference reports. These factors collectively ensure the credibility and scientific robustness of the research outcomes.

Thus, the scientific task set in the dissertation has been fully accomplished, and the applicant 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 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 dissertation exhibits a coherent structure and a mature scientific writing style. It is written in professional English that meets the conventions of technical literature in chemical and materials engineering. The exposition is sequential and logically consistent, guiding the reader from theoretical principles to experimental design, data interpretation, and final conclusions.

The Introduction clearly formulates the purpose, objectives, and research hypotheses. It establishes the significance of developing organo-mineral coatings with tunable hydrophobicity and outlines the novelty of using red mud and hierarchical ZnO particles as functional components. The introduction also provides a brief overview of applied methods and anticipated outcomes.

The first chapter reviews the theoretical background of surface wettability and the state-of-the-art in hydrophobic coating technologies. The author critically examines existing fabrication methods, highlighting their limitations in scalability and

environmental compatibility. This literature analysis sets the conceptual foundation for the experimental part.

The second chapter details the experimental methodology with accuracy and completeness. The description of raw materials, synthesis procedures, and analytical techniques ensures transparency and reproducibility. The inclusion of multiple complementary methods (SEM, XRD, FTIR, PL, goniometry) demonstrates the comprehensiveness of the study.

Chapters three through five are dedicated to experimental results and their interpretation. Each section begins with a concise description of the task, followed by presentation of data in figures and tables, and concludes with a well-reasoned discussion. The author interprets findings through established theoretical frameworks, such as Cassie–Baxter and Wenzel models, ensuring logical consistency. The progression from red mud-based coatings to ZnO composites and finally to hybrid organo-mineral systems illustrates the systematic nature of the research.

The sixth chapter extends the investigation to thin organic layers on textured substrates, exploring their effect on wetting and condensation phenomena. The results are discussed in the context of practical applications, adding depth to the overall study.

The Conclusions synthesize the entire research, restating the main achievements and confirming that the objectives have been fully met.

In terms of language and style, the dissertation maintains academic rigor, precision, and clarity. The author uses accepted terminology, avoids colloquial expressions, and ensures that technical terms are applied consistently. The writing is concise yet sufficiently detailed to convey experimental nuances. The logical sequence of chapters, integration of figures, and systematic referencing create a coherent and easily navigable document.

Formatting, citations, and bibliographic references conform to academic requirements. The overall structure ensures that the reader gains a comprehensive understanding of both the experimental and theoretical aspects. The clarity of exposition and stylistic consistency contribute to the high communicative quality of the work.

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's scientific works are characterized by a high level of scientific novelty and methodological soundness. All publications are made in compliance with the principles of academic integrity, which is confirmed by the correctness of citations and the absence of borrowings without references. The applicant's contribution to co-authored publications is significant and decisive for the results obtained.

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

Shortcomings and comments on the dissertation.

1. The dissertation employs water as the sole test liquid for wettability evaluation, as seen in Chapters 3–5 (e.g., Figs. 3.7, 5.2). Including at least one additional probe liquid - such as diiodomethane or ethylene glycol - would enable surface-energy decomposition and provide a fuller picture of polarity effects and adhesion mechanisms.
2. Chapter 5 reports high UV stability of ZnO-based coatings (Fig. 5.6), but the text provides qualitative observations rather than explicit numerical relationships between exposure duration and contact-angle reduction. Plotting the degradation kinetics could clarify whether the behavior follows linear, exponential, or threshold patterns.

3. In Section 3.1, the calcination temperature is fixed at 950 °C, yet no justification is provided for this specific choice, nor is there a comparison with lower or higher temperatures. Since temperature strongly affects phase composition and particle morphology, a brief rationale or reference to preliminary optimization would strengthen the methodological transparency.
4. Chapter 4 presents several morphologies obtained under varying precursor ratios and pH, but it is not stated whether the resulting particle shapes are reproducible across independent synthesis batches. Given that morphology critically affects wetting, reproducibility data would increase confidence in scalability.
5. The PL spectra illustrating dopant effects on ZnO emission lack axis labels for relative intensity normalization. Without specifying whether intensities are normalized by maximum or integrated area, the reader cannot directly compare the relative photoactivity of doped versus pure samples.
6. Sections 1.3 and 5.4 both discuss the Cassie–Baxter and Wenzel models, sometimes repeating identical equations and definitions. While this reinforces conceptual continuity, it slightly interrupts the flow of experimental reasoning.
7. Although the introduction emphasizes sustainability and waste valorization, later chapters (3–5) focus mainly on performance metrics without returning to the ecological dimension. A brief quantitative estimation - such as the potential reduction in red-mud waste or CO₂ footprint - would enhance the practical framing of the results.
8. A few figures use inconsistent labeling conventions - for example, “Fig. 4-5” instead of “Fig. 4.5”, and the symbol “W” occasionally appears where “ θ ” (contact angle) would be standard. Additionally, the term “porosity degree” might be better expressed as “porosity percentage.”

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.


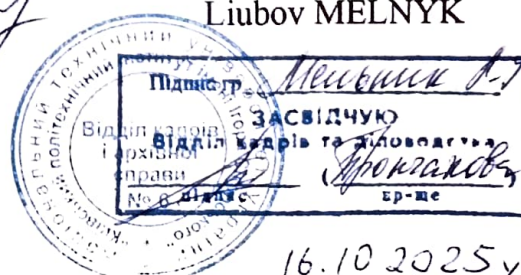
Conclusion on the dissertation

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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16.10.2025 y