

Review

**official reviewer Vasylenko Olha Oleksandrivna,
candidate of technical sciences, associate professor**

for a dissertation **Du Xin (Ду Сінь)**

**«Technological support of strength and durability at the manufacture and
repair of component parts for branch mechanical engineering»,**

**(«Технологічне забезпечення надійності та довговічності деталей
загального машинобудування при їх виготовленні та відновленні»),**

applied for the degree of Doctor of Philosophy,

from the field of knowledge **13 - «Mechanical engineering»,**

on specialty **133 - «Industrial engineering».**

1. Relevance of the dissertation topic.

Mechanical equipment causes a lot of losses due to friction and wear. Once key mechanical parts are worn excessively, it will cause major safety accidents. Since the wear causes the surface roughness, the electric vehicle locking pin can't work properly. If the electric vehicle brakes suddenly at high speed, the battery box will be thrown out. The vehicle will lose control, which results in catastrophic consequences. Wear problems have always affected the life of enterprise products, but it cannot be quantitatively analyzed by the engineers during the mechanical design. For this reason, improving anti-wear technology has always been one of hot spots for enterprises. In view of the wear problem of mechanical parts, remanufacturing technology can be used to repair and upgrade the surface

performance of mechanical parts. Remanufacturing engineering has also attracted the attention of many scientists. It can save businesses a lot of money. It can save a lot of money for enterprises. At present, Ukraine and the United States and other countries pay great attention to the research of this technology. The United States Department of Defense had included "new remanufacturing technologies" among the new priorities of the defense industry for the period.

Remanufacturing engineering performs repairs through surface deposition. The composite coating process achieves multiple surface functions. It enables high strength and anti-wear of the coating on mechanical parts. Friction-reducing coatings are used to reduce surface friction and improve wear resistance. Surface repair methods are used on many remanufacturing projects. ESD technology has many advantages compared with other remanufacturing methods, such as lower cost of use, simple and convenient equipment, reduced material waste, and less environmental pollution.

The research of a variety of process methods to improve surface wear resistance has positive scientific research significance with ESD technology. The article proposed the composite coating process to solve the reliability problem of key mechanical remanufactured parts. It increased the service life of the product, enhanced the wear resistance of the product, solved practical problems at a lower cost, and had strong industrial practical value.

2. Connection with scientific programs, topics, plans.

The work was performed in accordance with scientific programs of research work of the Ministry of Education and Science of Ukraine "Scientific methodology

of parts working surfaces maintenance properties providing by energy-efficient environmentally friendly methods" (№ 0116U002756).

3. Scientific novelty of the obtained results.

On the basis of analytical, scientific and experimental research in the dissertation for the first time:

—SKH51 material was deposited as a transitional coating by electro-spark deposition method. High-speed steel SKH51 has both wear resistance and impact toughness. During the deposition process, there are almost no microcracks on the surface.

—Using the abrasion width method, the wear resistance of ESD coatings was investigated. Because of uneven micro-textures of the ESD coating, the abrasive particles can be easily embedded in the micro-texture, which will bring large errors to measure the wear quality of the coating. The wear width is measured by the microscope system, which is simpler and more accurate.

—ESD coatings were comprehensively evaluated with an evaluation model based on the normalization method. Normalization processing factors include parameters such as deposition quality, coating thickness, roughness, Vickers hardness and wear width. Evaluation factors were weighted using weighting factors. The optimal deposition process is obtained.

4. Theoretical significance of the dissertation.

The theoretical significance of this paper lies in:

—The article combines the theory of composite coatings to propose co-free SKH51 material as a transition coating between carbon steel and cobalt-containing

WC coatings, which is scientifically verified for increasing surface wear resistance and increasing the thickness of wear-resistant layer. And the composite gradient coating structure on the surface has better impact toughness than a single coating.

—Further study the simplified theoretical model of the wear volume, the abrasion marks width was carried out to assess the abrasion resistance of ESD coatings and to reduce the effect of environmental errors.

—Anti-friction coating was formed by graphene oxide and sodium silicate, which can improve the surface quality of the coating. The use of GO to solve the agglomeration of lubricating nanoparticles has a strong theoretical research value.

—Process of transition coatings was optimized with a comprehensive evaluation model. The maximum value of the objective model was derived and evaluated with the normalization method and weighting factors method.

—Soft metal was continuously deposited with RC circuits, pneumatic vibration and reasonable gaps. The continuous deposition of low-temperature soft metals is theoretically discussed.

5. Practical significance of the results of the dissertation.

The results and processes in the dissertation section have been used in automotive company in China. An anti-wear composite coating is generated by combining a wear-resistant coating and a soft metal which extends the life of the product. This method allows the enterprise to reduce maintenance costs and obtain certain economic benefits. This composite coating technology greatly improves the life of parts in open environments. Key parts of electric vehicle lift mechanisms can be repaired and extend service life. This technology can also be used for other

mechanical parts. Compared with other processes, it is more environmentally friendly and has lower process costs. It has great market prospects in the remanufacturing industry.

6. The main results obtained personally by the author

Evaluating the main results of the thesis submitted for defense, it is necessary to emphasize their theoretical validity and the orientation of the acquirer Du Xin to a clear formulation of his own position.

The main provisions of the dissertation are scientifically substantiated, clear logical conclusions are made, and practical recommendations are provided for the introduction of the developed technology into production. The work contains all the necessary theoretical, methodological, methodical and analytical studies, properly covered in the relevant sections.

The scientific validity and reliability of the results presented in the dissertation work is ensured by the creative use of scientific approaches, systematic study and generalization of the results of scientific developments by scientists in the world branch of mechanical engineering.

An analysis of the plagiarism check report for the presence of textual borrowings (Unicheck program) was carried out. The reviewers came to the conclusion that Du Xin (Ду Сін) «Technological support of strength and durability at the manufacture and repair of component parts for branch mechanical engineering», («Технологічне забезпечення надійності та довговічності деталей загального машинобудування при їх виготовленні та відновленні») is the result of independent research of the acquirer and does not contain elements of plagiarism

and borrowing in accordance with the resolution of the CMU dated 12.01.2022 No. 44, paragraph 9. The used ideas, results and texts of other authors have a link to the corresponding source.

7. Number of scientific publications.

The results of the dissertation are reflected in 21 printed works, including: 4 scientific specialized publications of Ukraine; 2 other international journals, 4 articles in international scientific publications, 4 of which were indexed in the Scopus/Web of Science Core, 11 meeting papers on scientific, scientific-practical and international conferences.

8. The degree of validity of scientific provisions.

The main scientific propositions and conclusions put forward in the paper are logically justified and developed based on multilateral research. The research task was developed on the basis of a thorough analysis of 197 literary sources and own research. In order to achieve the goals of the dissertation, the author completes a step-by-step program of dissertation research at a high scientific level under the guidance of a supervisor.

A large variety of advanced experimental methods and tests were used in the experimental research, as well as mathematical modeling and mathematical-statistical processing of the results.

The comprehensive solution of the task, modern comprehensive experiments and analysis of the obtained results, the recognition of the proposed technical solutions by the industry, as well as the extensive discussion of the research results in scientific conferences and publications allow us to conclude that the validity of

the scientific statements and the reliability of the research results are high.

9. The structure and content of the dissertation, its completeness and compliance with the established requirements for design.

The dissertation consists of an abstract, an introduction, four chapters, conclusions, a list of used literary sources and appendices. The thesis is presented on 152 pages of the main text, including 40 tables and 70 figures.

In the dissertation work, the rules of planning and conducting scientific research are followed, and modern methods of research and processing of experimental results are used. The scientific novelty of the results of the work is based on comprehensive research, which was used at the appropriate level with the use of generally recognized research methods.

The dissertation is written in English and Ukrainian. The style and presentation of the work is logical, consistent and meets the requirements for printed works. The content of the work presents the results of scientific research and their approbation in practice. When presenting the text, modern scientific and lexical terminology is mainly used.

10. Discussion clauses, comments and wishes regarding the content.

There are still some issues that have not been analyzed in detail in the paper.

1) Ni material is usually chosen as the transition coating of WC material in ESD coatings. But the author selected SKH51 material as transition coating. It is not reflected in the article in comparison with transition coatings of other materials. It can be compared by wear resistance or other evaluation methods.

2) In the composite coating, B83 is used as the outer anti-friction layer, why

not use Ag and other soft materials to further reduce the friction coefficient? in the dissertation, such the analyses and explanations are not clear and comprehensive enough.

3) The idea of Go Gel coatings is good. Is it possible to increase the measurement of the Vickers hardness of the coatings, which it does not analyse further to compare with metal coatings in the dissertation? It will be very promising technology if it can replace metal coatings.

4) SKH51 and WC coatings form a gradient structure that increases the wear resistance of the coating. Is it possible that other single coatings in ESD deposition technology can achieve wear resistance? The article is not clear in this aspect of the explanation.

These remarks do not reduce the overall positive assessment of the dissertation work.

General conclusion

Dissertation work Du Xin (Ду Сін) «Technological support of strength and durability at the manufacture and repair of component parts for branch mechanical engineering», («Технологічне забезпечення надійності та довговічності деталей загального машинобудування при їх виготовленні та відновленні»), which was submitted for defense to the specialized academic council for obtaining the degree of Doctor of Philosophy in the field of knowledge 13 – Mechanical Engineering with a specialty 133 – Industrial Engineering according to its relevance, scientific and theoretical level, main results of validity, main provisions and results published in professional publications, the novelty of the statement and practical significance

meet the requirements of the order of the Ministry of Education and Culture of Ukraine No. 40 of January 12, 2017 "On approval of requirements for the preparation of a dissertation" and Resolution of the Cabinet of Ministers of Ukraine of January 12, 2022 No. 44 "On approval of the Procedure for awarding the degree of Doctor of Philosophy and cancellation of the decision of the one-time specialized academic council of a higher education institution, scientific institution on awarding the degree of Doctor of Philosophy" with changes introduced in accordance with Resolution of the Cabinet of Ministers No. 341 dated 03/21/2022.

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