The Decision
of the One-Time Specialized Academic Council
for Awarding the Degree of Doctor of Philosophy

The Doctor of Philosophy degree seeker, **Tan Kun**, born in 1993, citizenship of People's Republic of China. He graduated from Nanchang Hangkong University in 2019 with a master's degree in Aerospace Propulsion Theory and Engineering. From 2019 until now, he has been a PhD student in the Department of Aircraft Engines Manufacturing Technologies at the National Aerospace University «Kharkiv Aviation Institute», Ministry of Education and Science of Ukraine, Kharkiv. He has successfully completed an accredited academic and research program in Major 134 Aerospace Engineering.

The composition of the One-Time Specialized Academic Council DF 24 was approved by the Order No. 297 clause 1.1 (unchanged) of the National Aerospace University «Kharkiv Aviation Institute» dated July 24, 2024, on the basis of the decision of the Academic Council of the National Aerospace University «Kharkiv Aviation Institute» (Minutes No. 14 dated 24.07.2024).

The chairman of the one-time specialized academic council –
Oleh BARANOV, Doctor of Technical Sciences, Professor; Head of the Department of Theoretical Mechanics, Mechanical Engineering and Robotic Systems of the National Aerospace University «Kharkiv Aviation Institute»;

reviewers –
Yuriy SHIROKY, Candidate of Technical Sciences, Associate Professor, Dean of the Faculty of Aviation Engines of National Aerospace University «Kharkiv Aviation Institute»;

Andrii BREUS, Candidate of Technical Sciences, Associate Professor at the Department of Theoretical Mechanics, Mechanical Engineering and Robotic Systems of the National Aerospace University «Kharkiv Aviation Institute»;

official opponents –
Anatolii SANIN, Doctor of Technical Sciences, Professor, Dean of the Faculty of Physics and Technology of the Oles Honchar Dnipro National University;

Ievgen KONOPLIANCHENKO, Candidate of Technical Sciences, Associate Professor, Associate Professor of the Sumy National Agrarian University Technical Service Department

at the meeting dated **September 5, 2024**, it was decided to award Tan Kun with the degree of Doctor of Philosophy in the Branch of Knowledge 13 Mechanical Engineering, Major 134 Aerospace Engineering on the basis of the public defense of the dissertation «Development of supersonic nozzles for cold spraying» in the Major 134 Aerospace Engineering.

The dissertation was prepared at National Aerospace University «Kharkiv Aviation Institute», Ministry of Education and Science of Ukraine, Kharkiv.

Scientific advisor – Oleksandr Shorinov, Cand. of Tech. Sci., Associate Prof. of the Dep. of Aircraft Engines Manufacturing Technologies of National Aerospace University «Kharkiv Aviation Institute».

The dissertation is presented in the form of a specially prepared manuscript, which reflects new scientifically based results of the research conducted by the degree seeker, which performs a specific research objective and is of great importance for the Branch of Knowledge 13 Mechanical Engineering. The dissertation is written in English and meets the requirements for dissertation formatting established by the Ministry of Education and Science. The volume of the main text of the dissertation is sufficient to cover the topic within the field of 13 Mechanical Engineering in the Major 134 Aerospace Engineering. Thus, the dissertation research complies with the requirements of clause 6 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, research institution to award the degree of Doctor of Philosophy, approved by Resolution No. 44 of the Cabinet of Ministers of Ukraine dated January 12, 2022 (as amended).

The main results of the dissertation are published in **20 research papers** on the topic of the dissertation. Among them 5 articles in scientific periodical publications included in category «А» of the List of scientific specialized publications of Ukraine, or in foreign publications indexed in the Web of Science Core Collection and/or Scopus databases; 8 articles in scientific periodical publications included in the List of scientific specialized publications of Ukraine (category «Б»); 5 conference papers which are indexed in the Web of Science Core Collection and/or Scopus databases; 2 conference papers of Ukrainian scientific and practical conferences.

Research papers that outline the main research results of the dissertation:

1. Kun, T., Jie, H. W., Markovych, S., & Wang, Y. Dimet Laval nozzle expansion section analysis and optimization. Journal of Engineering Sciences, 2021, 8(2): F6-F10. DOI: https://doi.org/10.21272/jes.2021.8(2).f2. (Scopus);

2. Kun, T., Jie, H. W., Markovych, S., & Wang, Y. Optimization of cold spray nozzles based on the response surface methodology. Journal of Engineering Sciences, 2024, 11(1): F1-F11. DOI: https://doi.org/10.21272/jes.2024.11(1).f1. (Scopus);

3. Tan, K. Analysis of spray particles entrance of Right-angle cold spray nozzle based on CFD. Mechanics and Advanced Technologies, 2023, 7(3(99)): F1-F11. DOI: https://doi.org/10.20535/2521-1943.2023.7.3.292244.

4. Tan, K., Hu, W., Shorinov, O., & Wang, YR. Multi-parameter coupled optimization of Al6061 coating porosity based on the response surface method. Aerospace Technic and Technology, 2024, 3(195): 59-67. DOI: https://doi.org/10.32620/aktt.2024.3.05.

The chairman and members of the One-Time Specialized Academic Council took part in the discussion and made comments:

Reviewer Yuriy SHIROKY:

1. Since the dissertation is related to the development of supersonic nozzles for spraying, particularly rotary nozzles, it would be worth reviewing the literature to provide existing analogues of such nozzles.

2. The dissertation does not describe how the geometric dimensions of the channels of multi-channel nozzles were calculated.

3. Paragraph 3.2 shows the results of studies of the influence of temperature and gas pressure, as well as the size of powder particles on the speed of Cu particles in the form of graphs, but no explanation is provided as to how exactly these factors affect the optimisation parameter.

4. In Chapter 4, numerical modelling of the deposition of powder particles with the substrate and prediction of the porosity of the coatings is performed, but the obtained results are not compared with experimental results, in particular, obtained by other authors.

5. The dissertation contains stylistic and spelling errors.

Reviewer Andrii BREUS:

1. The applicant should provide examples of parts for spraying on the inner surfaces on which it is proposed to use developed rotary nozzles, as well as indicate the minimum diameter for spraying.

2. In paragraph 3.1, the applicant investigated the effect of gas pressure at the inlet to the nozzle of the DYMET-405 machine in the range from 0.8 MPa to 1.2 MPa. However, according to the technical characteristics of the equipment, a working pressure of 0.5 MPa to 0.8 MPa is recommended. Therefore, the question arises as to the expediency of increasing and investigating the pressure up to 1.2 MPa.

3. The resolution of the images in Figures 3.28, 3.32, 3.35, 4.28 and 4.29 is too small, making it difficult to perceive the given simulation results.

4. It would be good to supplement the fourth chapter of the dissertation with experimental studies of the porosity of the coating and compare it with the predicted values obtained using empirical dependencies and modelling.

Official opponent Anatolii SANIN:

1. In the thesis, the calculation of the geometric dimensions of supersonic nozzles for spraying was performed. Still, it was not clearly stated which criterion was used for nozzles geometry optimization.

2. The author notes in the first chapter that currently, depending on the working pressure of the gas, there are two types of cold gas-dynamic spraying – high and low, but it is not justified why the dissertation focuses on nozzles for high pressure.

3. In the thesis the results of multifactor optimizatio of cold gas dynamic spraying mores are presented, however, the justification of the investigated parameters as well as the intervals is not sufficiently complete.

4. There is no justification for choosing powder and substrate materials for high-speed collision simulation in the dissertation.

5. The acquirer introduced the deformation coefficient of an individual particle when it collides with the substrate, but the impact of subsequent particles arriving on it, which additionally deform the first one, is not considered.

Official opponent Ievgen KONOPLIANCHENKO:

1. The applicant proposed nozzles for spraying on internal and hard-to-reach surfaces of parts. It would be worthwhile to specify what these parts are, their materials and operation conditions, and the minimum internal diameter of the surfaces for spraying.

2. The applicant shows the dependence of the temperature and speed of the powder particle at the exit from the nozzle on the spraying modes, but these parameters are of interest at the moment of contact with the surface, taking into account the effect of the spraying distance.

3. To simulate the impact of powder particles with the substrate, it would be expedient to choose the values of their temperature and speed at the moment of collision, obtained from the results of the simulation of the flow with particles in the nozzle. However, the applicant used other values of these parameters as initial data.

4. The applicant should explain the influence of the substrate temperature on the porosity of the coatings and justify the need to take this parameter into account, which was studied in Chapter 4, since the substrate temperature has a more significant effect on the coating-substrate interface and, accordingly, on the adhesion strength. There is also a question of managing this parameter during the spraying process.

Results of the open vote:

> «In favor» – **5**;
> «Against» – **none**;
> «Abstentions» – **none**.

Based on the results of an open vote, the One-Time Specialized Academic Council shall **award Tan Kun with a Doctor of Philosophy** in the Branch of Knowledge 13 Mechanical Engineering, Major 134 Aerospace Engineering.

The video of the dissertation defense is attached.

No dissenting opinion from a member of the One-Time Specialized Academic Council was registered.

The chairman of the One-Time Specialized
Academic Council   Oleh BARANOV

The signature of Oleh BARANOV, the
chairman of the One-Time Specialized
Academic Council, is hereby certified by

Academic secretary of National Aerospace
University «Kharkiv Aviation Institute»   Tetiana BONDARIEVA