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

The Doctor of Philosophy degree seeker, **Hu Wenjie**, born in 1989, citizenship of People's Republic of China. He graduated from Nanchang Hangkong University in 2019 with a master's degree in Aerospace Engineering. From 2019 until now, he has been a PhD student in the Department of Aircraft Engines Manufacturing Technologies at 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 Subject Area 132 Material Sciences.

The composition of the One-Time Specialized Academic Council DF 26 was approved by the Order No. 414 clause 1.7 of National Aerospace University «Kharkiv Aviation Institute» dated October 23, 2024, on the basis of the decision of the Academic Council of National Aerospace University «Kharkiv Aviation Institute» (Minutes No. 3 dated 23.10.2024).

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 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 National Aerospace University «Kharkiv Aviation Institute»;

official opponents –

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

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

at the meeting dated **December 9, 2024**, it was decided to award Hu Wenjie with the degree of Doctor of Philosophy in the Field of Knowledge 13 Mechanical Engineering, Programme Subject Area 132 Material Sciences on the basis of the public defense of the dissertation «Cold spraying of protective and restorative coatings on parts of aviation engineering made of titanium alloys» in the Programme Subject Area 132 Material Sciences.

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 Field 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 Programme Subject Area 132 Material Sciences. 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 **19 research papers** on the topic of the dissertation. Among them 7 articles in scientific periodical publications included in category «A» 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; 6 articles in scientific periodical publications included in the List of scientific specialized publications of Ukraine (category «Б»); 4 conference papers indexed in the Web of Science Core Collection and/or Scopus databases; 1 conference paper of Ukrainian scientific and practical conferences; 1 utility model patent (Chinese patent).

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

1. Wenjie Hu, O. Shorinov. Optimization of Cold Spraying 90° Rectangular Nozzle Technological Parameter via Response Surface Method. Journal of Engineering sciences, 11(2), 2024. (Scopus, Q4).

2. Wenjie Hu, Kun Tan, Sergii Markovych, Tingting Cao. Study on structure and technological parameters of multi-channel cold spraying nozzle, Eastern-European Journal of Enterprise Technologies, 5 (113), 2021. (Scopus, Q3).

3. Wenjie Hu, Tan K., S. Markovych, Liu X. L. Study of a Cold Spray Nozzle Throat on Acceleration Characteristics via CFD. Journal of Engineering Sciences, 2021, 8: 19-24. (Scopus, Q4).

4. Wenjie Hu, K. Tan, S. Markovych, T. T. Cao, X. L. Liu. Research on the adhesive property of Al+Ti mixed powder deposited on Ti6Al4V substrate by CS using Abaqus/Explicit, Metallophysics and Advanced Technologies. 2022. (Scopus, Q3).

5. Wenjie Hu. Effects of different metal particles on cold spray deposition onto Ti-6Al-4V alloy via Abaqus/Explicit. Journal of Engineering Sciences. 2020, 7:19-25. (Scopus, Q4).

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

Reviewer Yuriy SHIROKY:

1. It would be appropriate to pay more attention to proving the scientific novelty of the obtained results of the dissertation based on their comparison with existing analogues and proving the superiority of the obtained over the existing ones.

2. The second chapter of the thesis presents the results of numerical modeling of the influence of individual geometric parameters of the nozzle for spraying on the particle velocity at the nozzle exit. However, this work can be replaced by calculating the optimal geometry of the nozzle for the required velocity, considering the initial gas parameters at the nozzle inlet.

3. The intervals of factor variation chosen for multivariate analysis should be set in a wider range.

4. The given recommendations for choosing the introduced criterion Y according to the claims of the applicant make it possible to predict the possibility of adhesion formation between the particle and the substrate, which is not confirmed by experiments, and no values of this adhesion and its changes in the given ranges of Y criteria are given.

5. There are spelling, stylistic and punctuation errors in the text of the dissertation.

Reviewer Andrii BREUS:

1. The dissertation does not describe what quantitative characteristics of coating adhesion can be achieved by following the recommendations and ensuring the powder particles' velocity at the nozzle's exit and what minimum adhesion values can be acceptable for the reliable operation of titanium parts with coatings.

2. There is no explanation for the choice of powder materials for the study and the particle sizes chosen (20 μm for titanium; 30 μm for aluminium, 15 μm for copper) as it would be useful to see the results for a range of sizes for each material.

3. The applicant considered the process of impact of powder particles from the point of view of energy balance, so it would be worthwhile to indicate the value of the kinetic energy of the particles necessary for forming bonds between the particle and the substrate.

4. The practical use of the proposed criterion Y is not resolved since its dependence on the velocity of the particles at the moment of contact with the substrate and not on the spraying modes is shown.

Official opponent Anatolii SANIN:

1. In sub-section 2.2.3, the author presented the results of the influence of the geometric parameters of the convergent-divergent cold spray nozzle, particularly the diameter of the throat, on the velocity of particles at the nozzle exit. However, it is worth noting that the diameter of the critical cross-section affects the gas flow rate through the nozzle, which is not mentioned in the dissertation and is mainly used as a criterion of optimality when developing a nozzle for spraying.

2. The proposed single-channel 90° nozzle shown in Fig. 2.23 has a rectangular channel shape, but all previous simulations on the effect of geometry and the recommendations given have been performed for a nozzle with a circular channel shape.

3. Research on the effect of the length of the gas supply channel on the gas velocity at the nozzle exit (sub-section 2.4.2.3) with the constant convergent part does not make sense since, from a practical point of view, it is only a matter of maintaining the temperature of the gas flow from the gas heater.

4. In the multi-channel nozzle proposed by the applicant (fig. 2.38), structural elements are used to turn the flow in the nozzle channel, the dimensions of which raise doubts about the possibility of their manufacture.

Official opponent Ievgen KONOPLIANCHENKO:

1. The dissertation does not explain the practical significance of the developed nozzles shown in Fig. 2.12.

2. There is no justification for selecting factors for multifactor analysis (section 2.5).

3. In Tables 2.4–2.6, the applicant made a conclusion about the possibility of adhesion of powder particles to the surface by comparing the particle velocities obtained from the results of numerical simulation under certain initial conditions with the values of the critical velocity. However, such a comparison is not correct since the velocity of the particles is measured at the nozzle exit, and the critical velocity is calculated at the moment of contact of the particle with the surface; that is, the

spraying distance is not taken into account, which affects the drop in velocity in the distance from the nozzle exit to the substrate.

4. In section 3.3, a new method for determining the critical velocity is proposed, based on the use of the introduced criterion Y, but there are no explanations and research on the influence of the particle diameter and material temperatures on the criterion Y.

5. The text contains spelling and punctuation mistakes.

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 Hu Wenjie with a Doctor of Philosophy** in the Field of Knowledge 13 Mechanical Engineering, Programme Subject Area 132 Material Sciences.

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