ANNOTATION

of the dissertation by **Kalmaganbetov Sanzhar Armanuly** on the topic: **«Optimization of geometric accuracy and reliability of transmission parts for electric vehicles»** submitted for the degree of Doctor of Philosophy (PhD) in the educational program 8D07113 – " Additive Manufacturing"

Relevance of the research. Provision of geometrical accuracy and reliability of gear wheels with reduction of their weight for transmission of electric vehicles. For this, an optimized design using mesh structures based on selective laser melting (SLM) technology is being developed. In the course of work, it is planned to improve the ratio of strength and mass of the gear wheel, select the parameters of lattice structures taking into account the features of the SLM process, determine the ways of compliance with geometric accuracy during printing and subsequent processing, as well as check the operability and reliability of manufactured samples through digital modeling and experimental tests.

The research objective is to consider the design, mechanical and technological features of gears for the transmission of electric vehicles using SLM technology.

The research tasks include the following:

- to analyze the existing designs of electric vehicle transmissions and scientifically substantiate the choice of a gearbox for light electric vehicles.
- to develop a 3d model of a gear wheel with an optimal tooth geometry and an internal lightweight structure.
- to study the possibilities of applying additive technologies, in particular the selective laser melting (SLM) method, for the manufacturing of gears with lattice infill.
- to perform numerical modeling of the stress–strain state, taking into account the lattice structure and the features of additive shaping.
- to carry out a topological optimization of the gear wheel design in order to reduce its mass, improve geometric accuracy, and increase reliability.

Scientific novelty of the study. In the proposal of new approaches to the design and manufacture of gears for the transmission of electric vehicles. Firstly, in contrast to the unloading methods used in traditional production methods, the possibility of reducing weight and maintaining strength by integrating mesh structures inside the gear housing is first comprehensively considered. Secondly, new solutions adapted to selective laser melting (SLM) technology have been proposed: methods have been developed aimed at preserving the geometric accuracy of the tooth profile, accounting for errors and deformations in printing and reducing them. Thirdly, the influence of mesh structures with different geometric parameters on the mass of the gears, the redistribution of stresses, the level of vibration and

noise was comprehensively analyzed on the basis of digital modeling and FEM. Fourth, evidence-based recommendations were developed that take into account the impact of the main parameters of the additive manufacturing process (laser power, layer thickness, scanning speed, orientation angle) on the quality of the finished product. Fifth, based on the data obtained by experimental tests, new scientific conclusions were presented that ensure the strength and reliability of gears manufactured using SLM technology.

Practical significance of the work. The introduction of mesh designs on gear wheels based on selective laser melting technology (SLM) will reduce their mass and the total weight of electric vehicles, which will save energy and increase the range. In addition, methods of optimizing printing parameters and ensuring geometric accuracy increase the quality and reliability of finished products. The results obtained will be applied not only in electric transport, but also in mechanical engineering, aviation and robotics, which will help increase the competitiveness of domestic production.

The reliability of the study results is confirmed by the application of the recommendations of regulatory documents in the area under consideration (GOST), the compliance of the reporting data with the study results.

Results submitted for defense:

- an analysis of the existing designs of electric vehicle transmissions has been carried out, and the choice of an efficient gearbox for light electric vehicles has been scientifically substantiated.
- a digital model of a gear wheel with an optimal tooth geometry and an internal lightweight lattice structure has been developed.
- the application of the selective laser melting (SLM) method for the manufacturing of gears has been scientifically justified, and its advantages and limitations have been demonstrated.
- taking into account the lattice structure, the stress–strain state of the gear wheel has been calculated, and its strength and reliability have been evaluated.
- in order to reduce mass, ensure geometric accuracy, and improve operational reliability, new design solutions for the gear wheel have been proposed.
- the strength and performance of the samples manufactured by additive technologies have been experimentally confirmed.

Publications:

1. Kalmaganbetov S.A., Isametova M., Troha S., Vrcan Ž., Markovic K., Marinkovic D. Selection of Optimal Planetary Transmission for Light Electric Vehicle Main Gearbox // Journal of Applied and Computational Mechanics. – 2024. – Т. 10. – № 4. – С. 742–753. – DOI: 10.22055/jacm.2024.46280.

2. Altay Y.A., Bazarbay B.B., Absadykov B.N. Method of identifying factors influencing defect formation in selective laser melting of heat-resistant alloy using acoustic emission method // News of the National Academy of Sciences of the Republic of Kazakhstan, Series of Geology and Technical Sciences. – 2025. – T. 2. – № 470. – C. 21–41. – ISSN 2224-5278.

3. Isametova M., Absalykov B., Bazarbay B., Smagulova G., Lepeshev N. Computer modeling and verification of mechanical properties of metal-polymer composite materials used in the technological process of layer-by-layer growing of parts // Вестник Евразийского Национального университета им. Л.Н. Гумилева. Серия «Технические науки и технологии». – 2022. – Т. 139. – № 2. – eISSN 2663-1326.