

## REVIEW

of the scientific advisor Doctor of Physical and Mathematical Sciences  
Professor Bolegenova Saltanat Alihanovna

for the thesis of Bergaliyeva Saltanat Amangeldinovna

“Standardization of Recycled Plastic Materials for Additive Manufacturing” submitted  
for the degree of Doctor of Philosophy (Ph.D.)  
in the educational program “8D07502 – Standardization and Certification (by industry)”

In the period from 2018 to 2023 Bergaliyeva S.A. studied at the educational program “8D07502 - Standardization and Certification (by industry)” of the al-Farabi Kazakh National University and at the doctoral program “8215 - Energy and Sustainable Engineering” of the University of Cadiz, Spain. She successfully completed the both doctoral programs with a recommendation to defend a dissertation.

Bergaliyeva S.A. is an independent doctoral student who is able to work with literary sources, collect, analyze, summarize data, set tasks and draw conclusions supported by her own arguments and evidence. These skills rapidly increased her level of professional training. In general, Bergaliyeva S.A. successfully coped with all the tasks set during the dissertation research.

The dissertation work "Standardization of Recycled Plastic Materials for Additive Manufacturing" is devoted to the study and standardization of thermo-mechanical properties of new raw materials for 3D printing from polylactide waste for further certification.

The first section of the dissertation presents a brief literature review of additive technologies' methods using fused filaments and granules, as well as the possibility of using secondary polymer materials in additive technologies. Special attention was paid to the study and analysis of the regulatory framework in the field of 3D printing.

The second section describes the methodology of conducting experiments performed during the implementation of the doctoral dissertation's tasks.

The third section contains developed by the doctoral student and approved in the standard of the organization St JSC 002-2023 “Polylactide for additive manufacturing. Test for accelerated hydrothermal aging” method of hydrothermal aging of polylactide samples, as well as the results of tests to determine the thermo-mechanical properties of polylactide after thermal and hydrothermal degradation.

The fourth section lists the results of the filaments' characteristics for 3D printing from recycled polylactide waste. According to the results of experimental work, polylactide waste has printable properties for use in additive technologies.

In the fifth section, the results of improving the thermomechanical quality indicators of polylactide debris by adding primary polylactide and titanium dioxide nanoparticles were displayed.

The sixth section contains the standard of the organization St JSC 001-2023 “Nanocomposites based on the polylactide and its waste with titanium dioxide nanoparticles for additive manufacturing. Technical conditions” developed and approved by JSC “Ust-Kamenogorsk Industrial Fittings Plant”.

These results were obtained during the scientific internship of Bergaliyeva S.A. in the laboratory of the University of Cadiz, Spain.

The dissertation work of Bergaliyeva S.A. was carried out in accordance with the plan of research work on the educational program “8D07502 - Standardization and Certification (by industry)”. The results of the thesis work of Bergaliyeva S.A. are reflected in 7 scientific publications, 3 of which were published in the proceedings of international conferences, 1 article in journal recommended by the Committee for Quality Assurance in the Field of Science and Higher Education of the Ministry of Science and Higher Education of the Republic of Kazakhstan, 3 articles in international peer-reviewed journal Polymers (IF- 5,0) included in the Web of Science (Clarivate Analytics, USA) and Scopus (Elsevier, Netherlands) databases.

Dissertation work by Bergaliyeva S.A. is a completed research work performed at a high scientific level. While working on her dissertation work, Bergaliyeva S.A. showed diligence, perseverance in achieving her goals, and responsibility in the implementation of non-standard research tasks.

I believe that the dissertation work of Bergaliyeva S.A. on the topic "Standardization of Recycled Plastic Materials for Additive Manufacturing" is a completed scientific work on an urgent topic, performed at a high scientific level, and the presented dissertation meets all the qualification requirements for dissertations for the degree of Doctor of Philosophy (Ph.D.), and Bergaliyeva S.A. deserves to be awarded the degree of Doctor of Philosophy (Ph.D.) by the educational program “8D07502 – Standardization and Certification (by industry)”.

Scientific advisor, Doctor of Physical and  
Mathematical Sciences, Professor,  
NJSC al-Farabi Kazakh National University

Bolegenova S.A.

РАСТАВЕРЖИВАЮЩИЙ  
өл-Фараби атындағы ҚазҰУ Ғылыми кадрлардың  
даярлау және аттестаттау басқармасының басшысы  
ЗАВЕРЯЮ  
Начальник управления подготовки и аттестации  
научных кадров КазНУ им. аль-Фараби  
Р.Е. Кудайбергенова

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