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**Должность:** к.ф.-м.н. , младший научный сотрудник

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08.12.1994, г. Ростов-на-Дону, Россия

**Должности:**

2012-2015 гг.– ФГАОУ ВО «Южный федеральный университет», физический факультет, кафедра физики наносистем и спектроскопии, лаборант

2015-2018 – ФГАОУ ВО «Южный федеральный университет», МИЦ «Интеллектуальные материалы», лаборант-исследователь

2018-2020 – ФГАОУ ВО «Южный федеральный университет», МИИ Интеллектуальных материалов, инженер-исследователь

2020-2022 – ФГАОУ ВО «Южный федеральный университет», МИИ Интеллектуальных материалов, младший научный сотрудник

2022-наст. время – ФГАОУ ВО «Южный федеральный университет», МИИ Интеллектуальных материалов, инженер

**Образование и ученые степени:**

Бакалавриат (2016): 03.03.02 Физика, Физический факультет, Южный федеральный университет, Ростов-на-Дону, Россия;

Магистратура (2018): 03.04.02 Физика, Институт интеллектуальных материалов, Южный федеральный университет, Ростов-на-Дону, Россия;

к.ф.-м.н. (2022): 01.04.15 Физика и технология наноструктур, атомная и молекулярная физика, Институт интеллектуальных материалов, Южный федеральный университет, Ростов-на-Дону, Россия. Тема диссертации: "Рентгеноспектральная диагностика катодных материалов в режиме operando".

**Направления исследований (ключевые слова):**

рентгеновская спектроскопия поглощения, рентгеновская дифракция, operando и in situ исследования, микрофлюидика, электрохимия, синхротронные исследования, гомогенный катализ в нефтехимии

### **Исследовательская активность**

#### **Участие в конференциях:**

Более 20 выступлений на всероссийских и международных научно-исследовательских конференциях, в т.ч. 8 наград за лучшие стендовые и устные доклады.

#### **Участие в экспериментах на синхротронах:**

Более 20 экспериментов на европейских и российских синхротронных источниках (ESRF, SLS, КИСИ-Курчатов), в т.ч. в качестве руководителя эксперимента.

Рентгеноспектральные и рентгеноструктурные исследования функциональных наноматериалов, материалов для электрохимии, гетерогенного и гомогенного катализа, в т.ч. с временным разрешением, в режиме in situ, operando и pump-probe.

#### **Область научных интересов:**

Проведение исследований в области разработки и диагностики функциональных наноматериалов, в частности, для электрохимии и катализа. Разработка микрофлюидных систем, в т.ч. для автоматизации и оптимизации химического синтеза с использованием методов in situ диагностики и машинного обучения.

Многомасштабное суперкомпьютерное моделирование структуры и свойств наноматериалов, квантово-химические расчеты. Разработка прикладного ПО для обработки экспериментальных данных. Разработка новых методов и подходов к исследованию наноматериалов рентгеноспектральными и рентгеноструктурными методами. Разработка новых наукоемких устройств и приспособлений для проведения исследований различными методиками (все этапы от концептуализации до подготовки КД, изготовления и испытаний).

#### **Методы:**

Спектроскопия рентгеновского поглощения, рентгеновская дифракция, квантовохимические расчеты, оптическая спектроскопия, масс-спектрометрия с индуктивно-связанной плазмой, конечно-элементный анализ механических свойств, вычислительная гидрогазодинамика, аддитивные технологии производства

#### **Научные публикации в реферируемых журналах:**

1. Shapovalov V. V., Chapek S. V., Tereshchenko A. A., Bulgakov A. N., Bagliy A. P., Volkov V. V., Konarev P. V., Soldatov M. A., Soldatov S. A., Guda A. A., Soldatov A. V. 3D-printed microfluidic system for the in situ diagnostics and screening of nanoparticles synthesis parameters // *Micro and Nano Engineering*. – 2023. – Т. 20. – С. 100224.

2. Kozyr E. G., Njoroge P. N., Chapek S. V., Shapovalov V. V., Skorynina A. A., Pnevskaya A. Y., Bulgakov A. N., Soldatov A. V., Pellegrino F., Groppo E., Bordiga S., Mino L., Bugaev A. L. Operando Laboratory X-ray Absorption Spectroscopy and UV-Vis Study of Pt/TiO<sub>2</sub> Photocatalysts during Photodeposition and Hydrogen Evolution Reactions // *Catalysts*. – 2023.

3. Hamdalla T. A., Aboraia A. M., Shapovalov V. V., Guda A. A., Kosova N. V., Podgornova O. A., Darwish A. A. A., Al-Ghamdi S. A., Alfadhli S., Alatawi A. M., Soldatov A. Synchrotron-based operando X-ray diffraction and X-ray absorption spectroscopy study of  $\text{LiCo}_0.5\text{Fe}_0.5\text{PO}_4$  mixed d-metal olivine cathode // *Scientific Reports*. – 2023. – T. 13, № 1. – C. 2169.
4. Guda A. A., Kirichkov M. V., Shapovalov V. V., Muravlev A. I., Pashkov D. M., Guda S. A., Bagliy A. P., Soldatov S. A., Chapek S. V., Soldatov A. V. Machine Learning Analysis of Reaction Parameters in UV-Mediated Synthesis of Gold Nanoparticles // *The Journal of Physical Chemistry C*. – 2023. – T. 127, № 2. – C. 1097-1108.
5. Gorbunov D. N., Nenasheva M. V., Borovoi I. A., Guda A. A., Vlasenko V. G., Trigub A. L., Shapovalov V. V., Zagrebaev A. D., Protsenko B. O., Soldatov A. V., Naranov E. R., Maximov A. L. Investigation of Rh/NR<sub>3</sub> catalytic systems in sequential stages of reductive hydroformylation engaging in situ X-ray absorption spectroscopy // *Journal of Catalysis*. – 2023.10.1016/j.jcat.2023.115194. – C. 115194.
6. Shvets P. V., Prokopovich P. A., Dolgoborodov A. I., Usoltsev O. A., Skorynina A. A., Kozyr E. G., Shapovalov V. V., Guda A. A., Bugaev A. L., Naranov E. R., Gorbunov D. N., Janssens K., De Vos D. E., Trigub A. L., Fonda E., Leshchinsky M. B., Zagackij V. R., Soldatov A. V., Goikhman A. Y. In Situ X-ray Absorption Spectroscopy Cells for High Pressure Homogeneous Catalysis // *Catalysts*. – 2022.
7. Shapovalov V., Kutukova K., Maletti S., Heubner C., Butova V., Shukaev I., Guda A., Soldatov A., Zschech E. Laboratory X-ray Microscopy Study of Microcrack Evolution in a Novel Sodium Iron Titanate-Based Cathode Material for Li-Ion Batteries // *Crystals*. – 2022. – T. 12, № 1.
8. Butova V. V., Aboraia A. M., Shapovalov V. V., Dzhangiryan N. A., Papkovskaya E. D., Ilin O. I., Kubrin S. P., Guda A. A., Soldatov A. V. Iron (II) fluoride cathode material derived from MIL-88A // *Journal of Alloys and Compounds*. – 2022. – T. 916. – C. 165438.
9. Shapovalova S. O., Guda A. A., Bubnov M. P., Smolentsev G., Rusalev Y. V., Shapovalov V. V., Zolotukhin A. A., Cherkasov V. K., Starikov A. G., Vlasenko V. G., Soldatov A. V. Temperature and Time-resolved XANES Studies of Novel Valence Tautomeric Cobalt Complex // *Chemistry Letters*. – 2021. – T. 50, № 11. – C. 1933-1937.
10. Shapovalov V., Guda A., Butova V., Shukaev I., Soldatov A. Laboratory operando XAS study of sodium iron titanite cathode in the li-ion half-cell // *Nanomaterials*. – 2021. – T. 11, № 1. – C. 1-13.
11. Guda A. A., Chegerev M., Starikov A. G., Vlasenko V. G., Zolotukhin A. A., Bubnov M. P., Cherkasov V. K., Shapovalov V. V., Rusalev Y. V., Tereshchenko A. A., Trigub A. L., Chernyshev A. V., Soldatov A. V. Valence tautomeric transition of bis(o-dioxolene) cobalt complex in solid state and solution // *Journal of Physics Condensed Matter*. – 2021. – T. 33, № 21.
12. Drozhzhin O. A., Grigoryev V. V., Alekseeva A. M., Samigullin R. R., Aksyonov D. A., Boytsova O. V., Chernyshov D., Shapovalov V. V., Guda A. A., Soldatov A. V., Stevenson K. J., Abakumov A. M., Antipov E. V. Revisited  $\text{Ti}_2\text{Nb}_2\text{O}_9$  as an Anode Material for Advanced Li-Ion Batteries // *ACS Applied Materials & Interfaces*. – 2021. – T. 13, № 47. – C. 56366-56374.
13. Aboraia A. M., Shapovalov V. V., Guda A. A., Butova V. V., Zahran H. Y., Yahia I. S., Soldatov A. V. Activation of  $\text{LiCoPO}_4$  in Air // *Journal of Electronic Materials*. – 2021. – T. 50, № 6. – C. 3105-3110.

14. Aboraia A. M., Moustafa M. G., Shapovalov V. V., Guda A. A., Elmasry F., Soldatov A. Enhancement of the electrochemical performance of LiCoPO<sub>4</sub> by Fe doping // *Ceramics International*. – 2021. – T. 47, № 22. – C. 31826-31833.
15. Smolentsev G., Milne C. J., Guda A., Haldrup K., Szlachetko J., Azzaroli N., Cirelli C., Knopp G., Bohinc R., Menzi S., Pamfilidis G., Gashi D., Beck M., Mozzanica A., James D., Bacellar C., Mancini G. F., Tereshchenko A., Shapovalov V., Kwiatek W. M., Czapla-Masztafiak J., Cannizzo A., Gazzetto M., Sander M., Levantino M., Kabanova V., Rychagova E., Ketkov S., Olaru M., Beckmann J., Vogt M. Taking a snapshot of the triplet excited state of an OLED organometallic luminophore using X-rays // *Nature Communications*. – 2020. – T. 11, № 1.
16. Shukaev I. L., Butova V. V., Chernenko S. V., Pospelov A. A., Shapovalov V. V., Guda A. A., Aboraia A. M., Zahran H. Y., Yahia I. S., Soldatov A. V. New orthorhombic sodium iron(+2) titanate // *Ceramics International*. – 2020. – T. 46, № 4. – C. 4416-4422.
17. Shapovalov V. V., Guda A. A., Kosova N. V., Kubrin S. P., Podgornova O. A., Aboraia A. M., Lamberti C., Soldatov A. V. Laboratory operando Fe and Mn K-edges XANES and Mössbauer studies of the LiFe<sub>0.5</sub>Mn<sub>0.5</sub>PO<sub>4</sub> cathode material // *Radiation Physics and Chemistry*. – 2020. – T. 175. – C. 108065.
18. Lisnevskaya I. V., Myagkaya K. V., Butova V. V., Shapovalov V. V., Rusalev Y. V., Zahran H. Y., Yahia I. S., Soldatov A. V. Preferences of the end members of the lanthanide series for A and B sites in BiFeO<sub>3</sub> // *Ceramics International*. – 2020. – T. 46, № 5. – C. 6333-6341.
19. Lisnevskaya I. V., Butova V. V., Rusalev Y. V., Shapovalov V. V., Zahran H. Y., Yahia I. S., Soldatov A. V. The effect of heterovalent doping on the stability and properties of multiferroic Aurivillius phases // *Applied Physics A: Materials Science and Processing*. – 2020. – T. 126, № 3.
20. Krasnovskaya O. O., Guk D. A., Naumov A. E., Nikitina V. N., Semkina A. S., Vlasova K. Y., Pokrovsky V., Ryabaya O. O., Karshieva S. S., Skvortsov D. A., Zhirkina I. V., Shafikov R. R., Gorelkin P. V., Vaneev A. N., Erofeev A. S., Mazur D. M., Tafeenko V. A., Pergushov V. I., Melnikov M. Y., Soldatov M. A., Shapovalov V. V., Soldatov A. V., Akasov R. A., Gerasimov V. M., Sakharov D. A., Moiseeva A. A., Zyk N. V., Beloglazkina E. K., Majouga A. G. Novel Copper-Containing Cytotoxic Agents Based on 2-Thioxoimidazolones // *Journal of Medicinal Chemistry*. – 2020. – T. 63, № 21. – C. 13031-13063.
21. Kirichkov M. V., Guda A. A., Budnyk A. P., Bugaev A. L., Lastovina T. A., Shapovalov V. V., Guda S. A., Trigub A. L., Rusalev Y. V., Chernyshev A. V., Lamberti C., Soldatov A. V. X-ray and optical characterization of the intermediate products in the Au<sup>3+</sup> reduction process by oleylamine // *Radiation Physics and Chemistry*. – 2020. – T. 175.
22. Aboraia A. M., Shapovalov V. V., Vetlitsyna-Novikova K., Guda A. A., Butova V. V., Zahran H. Y., Yahia I. S., Soldatov A. V. First-principle calculation for inherent stabilities of Li<sub>x</sub>CoPO<sub>4</sub>, Na<sub>x</sub>CoPO<sub>4</sub> and the mixture Li<sub>x</sub>NayCoPO<sub>4</sub> // *Journal of Physics and Chemistry of Solids*. – 2020. – T. 136. – C. 109192.
23. Aboraia A. M., Shapovalov V. V., Guda A. A., Butova V. V., Soldatov A. One-pot coating of LiCoPO<sub>4</sub>/C by a UiO-66 metal-organic framework // *RSC Advances*. – 2020. – T. 10, № 58. – C. 35206-35213.
24. Vetlitsyna-Novikova K. S., Butova V. V., Pankin I. A., Shapovalov V. V., Soldatov A. V. Zirconium-Based Metal-Organic UiO-66, UiO-66-NDC and MOF-801 Frameworks. Influence of the Linker Effect on the Hydrogen Sorption Efficiency // *Journal of Surface Investigation*. – 2019. – T. 13, № 5. – C. 787-792.

25. Lisnevskaya I. V., Butova V. V., Perebeinos M. I., Myagkaya K. V., Letovaltsev A. O., Shapovalov V. V., Zahran H. Y., Yahia I. S., Soldatov A. V. On the Possibility of Synthesizing  $\text{Bimno}_3$  at Ambient Pressure Using Low-Temperature Methods // *Comments on Inorganic Chemistry*. – 2019. – T. 39, № 5. – C. 270-286.
26. Kirichkov M. V., Polyakov V. A., Tereshchenko A. A., Shapovalov V. V., Guda A. A., Soldatov A. V. Synthesis of Palladium Nanoparticles on the Surface of Cerium(IV) Oxide under the Action of Ultraviolet Radiation and Their Characterization // *Nanotechnologies in Russia*. – 2019. – T. 14, № 9-10. – C. 435-443.
27. Chernyshev A. V., Guda A. A., Cannizzo A., Solov'Eva E. V., Voloshin N. A., Rusalev Y., Shapovalov V. V., Smolentsev G., Soldatov A. V., Metelitsa A. V. Operando XAS and UV-Vis Characterization of the Photodynamic Spiropyran-Zinc Complexes // *Journal of Physical Chemistry B*. – 2019. – T. 123, № 6. – C. 1324-1331.
28. Butova V. V., Bulanova E. A., Polyakov V. A., Guda A. A., Aboraia A. M., Shapovalov V. V., Zahran H. Y., Yahia I. S., Soldatov A. V. The effect of cobalt content in Zn/Co-ZIF-8 on iodine capping properties // *Inorganica Chimica Acta*. – 2019. – T. 492. – C. 18-22.
29. Shapovalov V. V., Guda A. A., Pankin I. A., Pohl A., Soldatov A. V. Structural Deformations During Cycling of the Conversion Cathode Nanocomposite Based on  $\text{FeF}_3$  // *Journal of Structural Chemistry*. – 2018. – T. 59, № 7. – C. 1719-1725.
30. Pankin I. A., Guda A. A., Tumanov N. A., Filinchuk Y., Lomachenko K. A., Bugaev A. L., Guda S. A., Shapovalov V. V., Lamberti C., Soldatov A. V. Experimental and theoretical study of hydrogen desorption process from  $\text{Mn}(\text{BH}_4)_2$  // *Journal of Alloys and Compounds*. – 2018. – T. 735. – C. 277-284.
31. Medvedev P. V., Soldatov M. A., Shapovalov V. V., Tereshchenko A. A., Gorban' I. E., Fedorenko A. G., Soldatov A. V. Analysis of the Local Atomic Structure of the MIL-88a Metal–Organic Framework by Computer Simulation Using XANES Data // *JETP Letters*. – 2018. – T. 108, № 5. – C. 318-325.
32. Guk D. A., Krasnovskaya O. O., Dashkova N. S., Skvortsov D. A., Rubtsova M. P., Dyadchenko V. P., Yudina E. S., Kosarev M. A., Soldatov A. V., Shapovalov V. V., Semkina A. S., Vlasova K. Y., Pergushov V. I., Shafikov R. R., Andreeva A. A., Melnikov M. Y., Zyk N. V., Majouga A. G., Beloglazkina E. K. New ferrocene-based 2-thio-imidazol-4-ones and their copper complexes. Synthesis and cytotoxicity // *Dalton Transactions*. – 2018. – T. 47, № 48. – C. 17357-17366.
33. Guda L. V., Kravtsova A. N., Kubrin S. P., Mazuritsky M. I., Kirichkov M. V., Rusalyov Y. V., Shapovalov V. V., Soldatov A. V. Structure and Chemical Composition of the Ordinary Chondrite Jiddat Al Harasis 055 // *Journal of Structural Chemistry*. – 2018. – T. 59, № 8. – C. 1858-1865.
34. Kirichkov M. V., Guda A. A., Budnyk A. P., Lastovina T. A., Bugaev A. L., Shapovalov V. V., Rusalev Y. V., Chernyshev A. V., Soldatov A. V. In situ analysis of the formation steps of gold nanoparticles by oleylamine reduction // *Journal of Structural Chemistry*. – 2017. – T. 58, № 7. – C. 1403-1410.
35. Bugaev A. L., Guda A. A., Lomachenko K. A., Shapovalov V. V., Lazzarini A., Vitillo J. G., Bugaev L. A., Groppo E., Pellegrini R., Soldatov A. V., Van Bokhoven J. A., Lamberti C. Core-Shell Structure of Palladium Hydride Nanoparticles Revealed by Combined X-ray Absorption Spectroscopy and X-ray Diffraction // *Journal of Physical Chemistry C*. – 2017. – T. 121, № 33. – C. 18202-18213.

36. Pohl A., Faraz M., Schröder A., Baunach M., Schabel W., Guda A., Shapovalov V., Soldatov A., Chakravadhanula V. S. K., Kübel C., Witte R., Hahn H., Diemant T., Behm R. J., Emerich H., Fichtner M. Development of a water based process for stable conversion cathodes on the basis of FeF<sub>3</sub> // *Journal of Power Sources*. – 2016. – Т. 313. – С. 213-222.
37. Ren S., Chen R., Maawad E., Dolotko O., Guda A. A., Shapovalov V., Wang D., Hahn H., Fichtner M. Improved Voltage and Cycling for Li<sup>+</sup> Intercalation in High-Capacity Disordered Oxyfluoride Cathodes // *Advanced Science*. – 2015. – Т. 2, № 10.
38. Chen R., Ren S., Yavuz M., Guda A. A., Shapovalov V., Witter R., Fichtner M., Hahn H. Li<sup>+</sup> intercalation in isostructural Li<sub>2</sub>VO<sub>3</sub> and Li<sub>2</sub>VO<sub>2</sub>F with O<sup>2-</sup>- and mixed O<sup>2-</sup>/F<sup>-</sup>- anions // *Physical Chemistry Chemical Physics*. – 2015. – Т. 17, № 26. – С. 17288-17295.
39. Pohl A. H., Guda A. A., Shapovalov V. V., Witte R., Das B., Scheiba F., Rothe J., Soldatov A. V., Fichtner M. Oxidation state and local structure of a high-capacity LiF/Fe(V<sub>2</sub>O<sub>5</sub>) conversion cathode for Li-ion batteries // *Acta Materialia*. – 2014. – Т. 68. – С. 179-188.

### **Российские гранты (за последние 5 лет)**

1. Минобрнауки РФ, Проект 075-15-2021-1363, Управляемая искусственным интеллектом роботизированная станция на источнике синхротронного излучения для ускоренной разработки новых перспективных материалов и их диагностики в режиме реального времени, 2021-2023, исполнитель
2. Минобрнауки РФ, Проект СП 1.3 (Приоритет-2030), Создание парка наукоемкого приборостроения, 2022-2022, исполнитель
3. Минобрнауки РФ, Проект 0852-2020-0019 (ПЧ ГЗ), Новые функциональные наноматериалы для применения в каталитических процессах и в технологиях для хранения и преобразования энергии, 2020-2022, исполнитель
4. РФФИ, Проект 17-02-01350\17, 3D атомная и электронная структуры наноструктурированных материалов для литий-ионных аккумуляторов на основе фторидов переходных металлов, 2017-2019, исполнитель
5. Минобрнауки РФ, Проект 16.3871.2017/ПЧ (ПЧ ГЗ), Пикометровая диагностика параметров 3D локальной атомной структуры наноматериалов на основе спектроскопии XANES, 2017-2019, исполнитель



**Viktor V. Shapovalov**

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**Academic positions:**

2012-2015 - Faculty of Physics, Department of Physics of Nanosystems and Spectroscopy, laboratory assistant

2015-2018 - Federal State Autonomous Educational Institution of Higher Professional Education "Southern Federal University", IIC "Intellectual Materials", laboratory assistant-researcher

2018-2020 - FGAOUO "Southern Federal University", IIC "Intellectual Materials", research engineer

2020-2022 - Federal State Educational Institution of Higher Education "Southern Federal University", Intellectual Materials Research Institute, junior researcher

2022-present - FGAOU VO "Southern Federal University", Intellectual Materials Research Institute, Engineer

**Education and Degrees:**

Bachelor's in Physics (2016): Department of Physics, Southern Federal University, Rostov-on-Don, Russia;

Master's in Physics (2018): The Smart Materials Research Institute, Southern Federal University, Rostov-on-Don, Russia;

PhD in Material science (2022): The Smart Materials Research Institute, Southern Federal University, Rostov-on-Don, Russia. Thesis title "Operando X-ray absorption studies of cathode materials".

**Research sectors (Keywords):**

X-ray absorption spectroscopy, X-ray diffraction, operando and in situ studies, microfluidics, electrochemistry, synchrotron studies, homogeneous catalysis in petrochemistry.

#### **Participation in conferences:**

Over 20 presentations at large-scale national and international research conferences, including 8 awards for the best poster and oral presentations.

#### **Participation in experiments at synchrotrons:**

Over 20 experiments at European and Russian synchrotron sources (ESRF, SLS, KISI-Kurchatov), including as experiment group leader. X-ray spectral and structural studies of functional nanomaterials, materials for electrochemistry, heterogeneous and homogeneous catalysis, including time-resolved, in situ, operando and pump-probe studies.

#### **Fields of interest:**

Development and characterization of functional nanomaterials for electrochemistry and catalysis. Development of microfluidic systems, including those for automation and optimization of chemical synthesis using in situ diagnostics and machine learning methods. Multiscale supercomputer modeling of nanomaterials structure and properties, computational quantum chemistry. Development of software for experimental data processing. Development of new methods and approaches to the study of nanomaterials by X-ray spectral and structural methods. Development of new science-intensive devices and instrumentation for research by different methods (all stages from conceptualization to manufacturing).

#### **Methods:**

X-ray absorption spectroscopy, X-ray diffraction, computational quantum chemistry, optical spectroscopy, inductively coupled plasma mass spectrometry, finite element analysis of mechanical properties, computational fluid dynamics, additive manufacturing

#### **Scientific publications in refereed journals:**

1. Shapovalov V. V., Chapek S. V., Tereshchenko A. A., Bulgakov A. N., Bagliy A. P., Volkov V. V., Konarev P. V., Soldatov M. A., Soldatov S. A., Guda A. A., Soldatov A. V. 3D-printed microfluidic system for the in situ diagnostics and screening of nanoparticles synthesis parameters // *Micro and Nano Engineering*. – 2023. – T. 20. – C. 100224.
2. Kozyr E. G., Njoroge P. N., Chapek S. V., Shapovalov V. V., Skorynina A. A., Pnevskaya A. Y., Bulgakov A. N., Soldatov A. V., Pellegrino F., Groppo E., Bordiga S., Mino L., Bugaev A. L. Operando Laboratory X-ray Absorption Spectroscopy and UV-Vis Study of Pt/TiO<sub>2</sub> Photocatalysts during Photodeposition and Hydrogen Evolution Reactions // *Catalysts*. – 2023.
3. Hamdalla T. A., Aboraia A. M., Shapovalov V. V., Guda A. A., Kosova N. V., Podgornova O. A., Darwish A. A. A., Al-Ghamdi S. A., Alfadhli S., Alatawi A. M., Soldatov A. Synchrotron-based operando X-ray diffraction and X-ray absorption spectroscopy study of LiCo<sub>0.5</sub>Fe<sub>0.5</sub>PO<sub>4</sub> mixed d-metal olivine cathode // *Scientific Reports*. – 2023. – T. 13, № 1. – C. 2169.



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